BLH ELECTRONICS, INC.

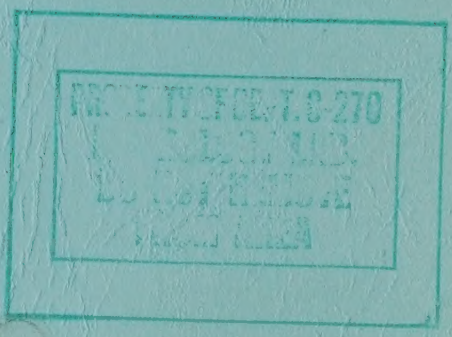
Model 120C
Strain Indicator

DOUGLAS AIRCRAFT COMPANY

MCDONNELL DOUGLAS
CORPORATION

E1573

OPERATING AND SERVICE MANUAL



120C STRAIN INDICATOR

TM-120C-3

BLH ELECTRONICS, INC.

WALTHAM, MASSACHUSETTS 02154 • (617) 890-6700

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BLH warrants the product(s) covered hereby to be free from defects in material and workmanship. BLH's liability under this guarantee shall be limited to repairing or furnishing parts to replace, f.o.b. point of manufacture, any parts which, within one (1) year from date of shipment of said product(s) from BLH's plant, fail because of defective workmanship or material performed or furnished by BLH. As a condition hereof, such defects must be brought to BLH's attention for verification when first discovered, and the material or parts alleged to be defective shall be returned to BLH if requested. BLH shall not be liable for transportation or installation charges, for expenses of Buyer for repairs or replacements or for damages from delay or loss of use or for other indirect or consequential damages of any kind. BLH may use improved designs of the parts to be replaced. This guarantee shall not apply to any material which shall have been repaired or altered outside of BLH's plant in any way so as, in BLH's judgment, to affect its strength, performance or reliability, or to any defect due in any part to misuse, negligence, accident or any cause other than normal and reasonable use, nor shall it apply beyond their normal span of life to any materials whose normal span of life is shorter than the applicable period stated herein. In consideration of the foregoing guarantees, all implied warranties are waived by Buyer. BLH does not guarantee quality of material or parts specified or furnished by Buyer, or by other parties designated by Buyer, if not manufactured by BLH. If any modifications or repairs are made to this equipment without prior factory approval, the above warranty can become null and void.

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PATENT INFORMATION

BLH Equipment is manufactured under one or more of the following patents:

2,771,579	*3,083,689*	*3,405,359*	*3,554,503*
2,815,480	*3,085,847*	*3,434,343*	*3,600,670*
2,846,645	*3,334,352*	*3,434,453*	*3,617,878*
2,932,776	*3,350,927*	*3,438,056*	*3,667,041*

Patented in Canada 1955, 1958, 1960, 1966, 1967, 1968, 1970.

BLH ELECTRONICS, INC.

WALTHAM, MASSACHUSETTS 02154 • (617) 890-6700 ®

BLH MANUAL CHANGES

MODEL 120C

MANUAL TITLE Strain Indicator

MANUAL PREFIX TM-120C-2
TM-120C-3

MAKE ALL CHANGES IN THIS MANUAL ACCORDING TO ERRATA AND CHANGE(S) LISTED BELOW

ERRATA: Page 2-9, SECTION II, Installation, Figure 2-9. Front Panel Control Data. Under Item 4, GAGE FACTOR, change the first sentence to read: The GAGE FACTOR control is calibrated for operation between 1. 5 and 4. 5.

Page 3-2, SECTION III, Operation, Paragraphs 3-21/ 3-22 Strain Calculation Formula. Change formula to read: $(T_2-T_1)\ 1000 + D_2-D_1$.

CHANGE: Page 1-1 SECTION I, General Information, Paragraph 1-15, Model 250 Calibration Check Unit. Delete paragraph; unit is obsolete and no longer offered for for sale. Delete all other references to this particular unit in manual context.

8/29/68 TME-120C-2

DATE CHANGE NUMBER

BLH MANUAL CHANGES

MODEL 120C

MANUAL TITLE Strain Indicator

MANUAL PREFIX TM-120C-2
TM-120C-3

MAKE ALL CHANGES IN THIS MANUAL ACCORDING TO ERRATA AND CHANGE(S) LISTED BELOW

ERRATA: Page 5-4, SECTION V, Maintenance, Paragraph 5-22, Electrical Adjustment - step i. Sentence should read: "Apply 5mV/V to the Indicator with the 625 Calibrator."

2/19/70
DATE

TME-120C-3-2
CHANGE NUMBER

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A2	279050-2		1	Assy, Inverter		
A3	279090-2			Assy, Measuring Circuit,		
	400007-1			Board; PC Measuring Circuit		
A3R101	134074-8			R: WW 50Ω, 1/2%, 1/4W		
R102	135645-8	1	3	R: Variable, 100Ω		
R103	*			R: WW, 1/2%		
R104	134075-8		2	R: WW, 4.5K, 1/2%, 1/4W		
R105	134082-8			R: WW, 450Ω, 1/2%, 1/4W		
R106	134073-8			R: WW, 55Ω, 1/2%, 1/4W		
R107				Same as R102		
R108	134076-8		2	R: WW, 800Ω, 1/2%, 1/4W		
R109				Same as R102		
R110	134083-8			R: WW, 950Ω, 1/2%, 1/4W		
R111				Same as R108		
R112				Same as R104		
A4				Assy Chassis		
A4A1	279125-2	2	11	Switch: ADD TO READING		
A4A1R113	135510-8			R: WW, 150Ω, .05%, 1/4W		
R123				Same as R113		
A4MP1	124852-8	1	1	Knob: ADD TO READING		
A4S104	274377-1	1	1	Switch: Rotary		
A4A2	202786-3		1	Assy, Counter and Gear Head		
A4A2MP1	275257-3		1	Gear Head		
MP2	202785		1	Counter		
MP3	202782-1		1	Index Window		
MP4	202778-1			Assy: Gear and Bearing		
MP5	133279-8			Gear: Drive, 104T		
MP6	133281-8			Gear: Idler, 20T		
MP7	128046-8			Ring, Retaining		
A4A2R125	101878-1	1	1	R: Variable 200Ω (Slidwire)		
A4C101	132504-8		1	C: 5μF (dual) 400V		
C102	131195-8		1	C: 1000μF, 15V		
A4F101	128584-8	1	5	Fuse: 1/8 amp.		
A4J1	135158-8	1	2	Binding Post: Green		
J2	135148-8	1	2	Binding Post: Red		
J3	135146-8	1	2	Binding Post: White		
J4	135149-8	1	2	Binding Post: Black		
J5				Same as J1		
J6				Same as J2		
J7				Same as J3		
J8				Same as J4		
J9	135099-8			Connector: 115Vac input		
J10	279102-1			Jack: Scope		
A4M101	400425-1	1	1	Meter, Null		
A4MP101	203301-1		1	Dial, Turn Counting (Gage Factor)		
MP102	203318-8		1	Knob: Balancing		
A4Q101	141719-8	1	1	Transistor GEZN404		
A4R124	204277-1	1	1	R: Variable, 100Ω (Gage Factor)		
R126	204863-1		2	R: WW, 500Ω, 0.05%, 1/4W		
R127				Same as R126		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A4R128	127220-8	1	2	R: Comp, 1500Ω, 10%, 1/2W		
R129				Same as R128		
R130	127219-8		1	R: Comp, 1200Ω, 10%, 1/2W		
R131	141923-8		1	R: WW, 330K, 1%, 1/4W		
R132	127213-8		1	R: Comp, 390K, 10%		
A4S101	133532-8			Switch: Toggle		
S102	133531-8		1	Switch: Toggle		
S103	205958-1			Switch: PB Interlock		
S104				P/O A4A1		
S105	132559-8		1	Switch Toggle		
A4TB101	124865-8	1	1	Terminal Strip		
A4XF101	131050-8		1	Fuse Holder		
A5	279136-2			Assy: Model 120 PS/C Power Supply		
A5C101	135108-8	1	2	C: 100μF, 25V		
C102		1		Same as C101		
C103	128095-8			C: 15μF, 200V		
A5CR101	135100-8	1		Rectifier		
A5F101	128841-8	5	1	Fuse 1/8A		
A5R101	132706-8		1	R: 15Ω, 5%, 1/2W		
R102	129833-8	1	1	R: 150Ω, 5%, 1/2W		
A5T101	133361-8	1	1	Transformer		
				MISCELLANEOUS		
BT101	F4BP	1	2	Battery: 6V for Model 120CB		
BT102				Same as BT101		
	202901-1		1	Battery Cable		
	102826-2	1	1	AC Power Cable W/Connectors Case		

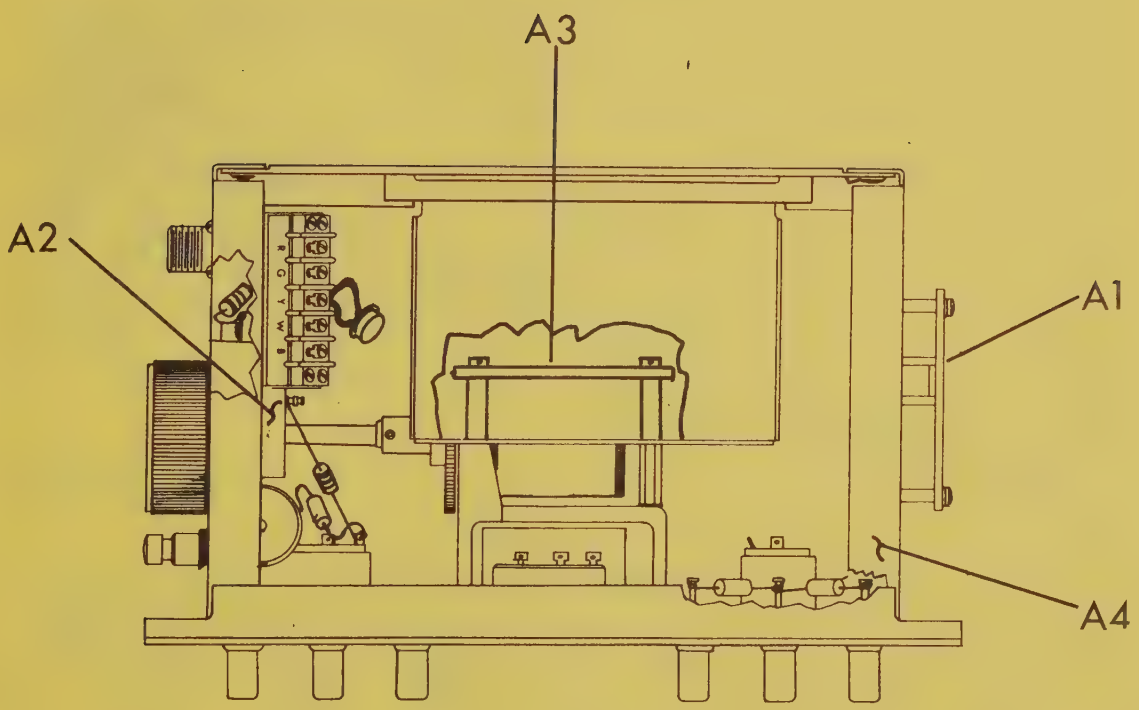

Figure 6-1. (REV.) Major Instrument Assemblies
(Sheet 4 of 5)

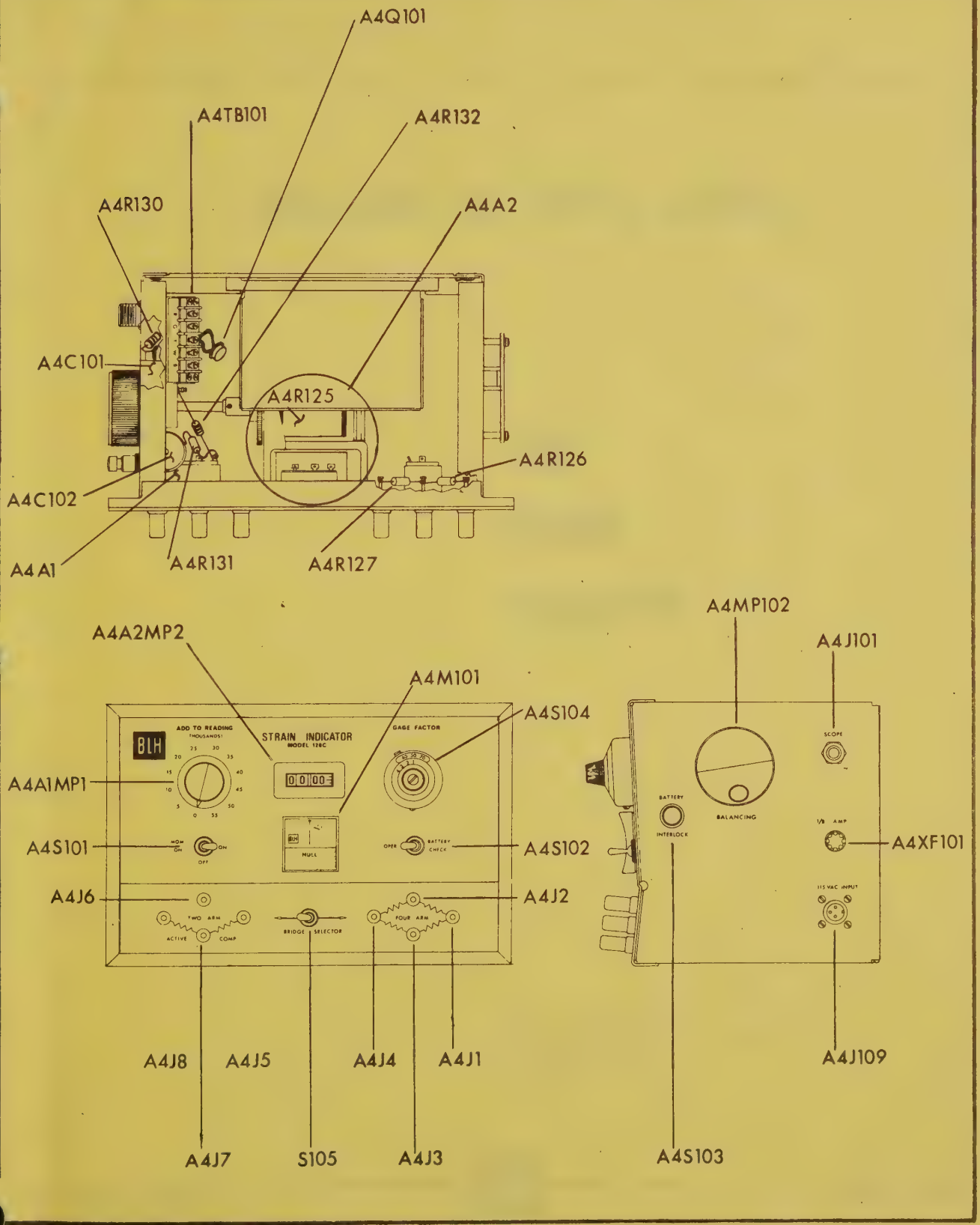

Figure 6-2/6-3. (REV) Assembly A4, Subassemblies and Components

OPERATING AND SERVICE MANUAL

120C
STRAIN
INDICATOR

Direct Manual Inquiries to:
Manager, Technical Publications Dept.,
BLH Electronics, Inc.

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April 1968

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Figure 1-1. Model 120C Strain Indicator

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. General Description.

1-3. The BLH Model 120C Strain Indicator, Figure 1-1, is designed to amplify, measure, and indicate the output of wire and foil strain gages. The instrument will accommodate a one, two, or four arm gage bridge configuration using the three or four wire system of strain measurement. Gages with resistances of 60-2000 ohms and having gage factors of 1.5 to 4.5 may be utilized with the indicator. Readout is digital, in microinches, eliminating possible interpretation and parallax errors. A 1000 Hz square wave generator provides excitation for the strain gage circuit and drives the phase demodulator. The square wave excitation minimizes the effect of capacitance in long cables, improving the readability of low level signals.

1-4. Identification.

1-5. The indicator may be used in field or laboratory applications depending upon the model ordered. The 120CB is a battery operated unit suitable for short run laboratory tests or field use. The 120CA is an ac operated instrument for laboratory use only. The model 120 PS/C Conversion Kit, available as an accessory, is used to convert the Model 120CB to ac operation. The Model 120CA may also be easily converted to battery operation. Complete conversion instructions for both models are provided in Section II of this manual.

1-6. Specifications.

1-7. Specifications which apply to the Model 120C are listed in Table 1-1. Specifications for the 120CA and 120CB are the same, with the exception of the power supply. Power supply specifications for both Models are also listed in Table 1-1.

1-8. Other Information.

1-9. Although designed primarily for use with strain gages, the indicator may be used to measure the mV/V output of a single transducer. A scope jack has been provided for observation of dynamic strain with a cathode rav oscilloscope. A simplified instruction sheet, sealed in plastic, is located on the side door of the instrument.

1-10. ACCESSORY EQUIPMENT.

1-11. Model 625 Precision Calibrator.

1-12. The Model 625 Precision Calibrator, Figure 1-2, provides fifty-five extremely accurate millivolt per volt output signals to check instrumentation associated with strain gages, millivolt sensors or transducers. The unit is substituted for the transducer or gages and the readout is then verified. Instrument accuracy is determined without the need to remove and substitute temporary indicators and amplifiers for tests.

1-13. Model 120 PS/C Conversion Kit.

1-14. The Model 120 PS/C Conversion Kit (not shown), available as an accessory, makes it possible to convert the Model 120CB to a Model 120 CA. The conversion kit comes supplied with a solid state power supply, power cord, connectors and all necessary hardware. Complete conversion instructions are provided with each kit.

1-15. Model 250 Calibration Check Unit.

1-16. The BLH Model 250 Calibration Check Unit, Figure 1-2, is essentially a half bridge circuit used to simulate an active and compensating gage. The potentiometer tap switch has a range of 0-20,000 microinches per inch, graduated in 10 steps of 2000 microinches each. The gage resistance is 120 ohms with a gage factor of 2.00.

1-17. Model 220 Portable Strain Gage Switching Unit.

1-18. Model 220 Switching Unit, Figure 1-2, provides manual switching of individual active-compensating gage pairs into the indicator. Up to ten active and compensating gage pairs may be used or one dummy gage can serve as compensation for a selected group of gages or for the entire ten gage installation. The unit is well suited to special installations where a series or particular group of strain gages must be switched into a single strain indicator and measurements taken from individual gages during a limited period of time. The Model 220 is also ideally suited for switching low level signal sensors such as thermocouples. While this instrument permits fast, precise measurements at minimum cost, it does not have a means for initially balancing the individual gages. The Model 225 Switching and Balancing Unit should be specified where initial balancing is required.

1-19. Model 225 Portable Switching and Balancing Unit.

1-20. Model 225 Ten Channel Switching and Balancing Unit, Figure 1-2, provides manual balancing and switching of strain gage networks. The unit is used where several readings must be taken on each of a group of strain gage networks and where the time factor is important because of economy, availability and testing facilities, ambient temperature variation, and "creep".

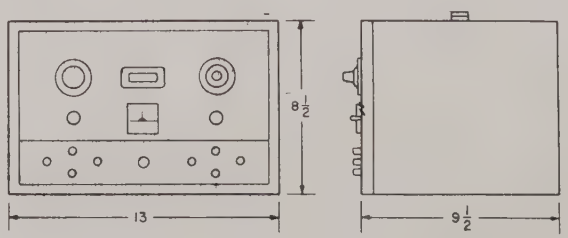
The primary advantage of this instrument is high repeatability made possible by low switch contact resistance. This characteristic is particularly important when half-bridge networks are used, since variations in contact resistance affect the strain gage reading.

1-21. Model 230 Semi-conductor Strain Gage Convertor.

1-22. Model 230 Semi-conductor Strain Gage Convertor extends the capabilities of the Model 120C to the semi-conductor gage area. The Model 230 has a unique circuit which allows the existing Gage Factor control on the Model 120 C to be used. The semiconductor gage factor is divided by 50 and the result dialed into the Gage Factor control. One of the features of the Model 230 is a three position Range Selector switch that increases the sensitivity of the Model 120 to either ± 1, 500 or ± 6, 000 microinches per inch, full scale, in the half-bridge configuration and ± 1, 500 microinches per inch, in the full-bridge configuration. Thus, the increased output of semiconductor strain gages at low strain levels is utilized to the fullest extent. A Coarse Zero switch is supplied with a range of ± 5, 000 microinches in ten calibrated steps of 1, 000 microinches each to compensate for the rather large initial zero unbalance which occurs in semiconductor strain gages.

Table 1-1. Model 120C Specifications.

TOTAL INDICATOR RANGE:	60, 000 microinches per inch.
COUNTER:	0 to 5, 000 microinches per inch; white numerals 1/4" high on black background.
NUMBER OF INTERVALS:	12
ACCURACY:	
1. Reference Switch:	±0. 1% per step (the errors at each step are not cumulative).
2. Gage Factor Dial:	Set at 2. 0, accuracy is ±0. 1% (or 5 microinches per inch, whichever is greater) sloping to ±0. 5% at settings of 1. 7 and 2. 3.
READABILITY:	1 microinch per inch.
INPUT:	1, 2 or 4 arm strain gage networks.
INPUT TERMINALS:	Color-coded five way binding posts.
GAGE FACTOR RANGE:	1. 5 to 4. 5
GAGE RESISTANCE RANGE:	60 to 2, 000 ohms
OUTPUT JACK:	
1. Impedance:	4, 000 ohms (approx.).
2. Dynamic Strain Range	0 to 5, 000 microinches per inch (0-100 mv).
3. Linearity	±1% of Full Strain Range.
BRIDGE EXCITATION:	3 v at 1, 000 cps (squarewave).
OPERATING TEMPERATURE RANGE:	+30°F to +130°F (-1. 1°C to +54°C).
ZERO DRIFT:	Not greater than ±5 microinches/hour
CONTROLS:	1. Gage Factor Control 2. On, Off, Momentary On Switch 4. Add-to-Reading Switch 5. Bridge Selector (2 or 4 arm bridge) 6. Scope Output 7. Interlock
SIZE:	13" W x 8-1/2 H x 9-1/2" D. (33. 02 x 21. 59 x 24. 13 cm)
WEIGHT:	18 pounds. (8. 16 kg)
POWER REQUIREMENT:	
1. Model 120CA	115V ± 10%, 50-60 cps, 4 w; ground terminals furnished on AC plug. Fused.
2. Model 120CB	Two standard 6 v batteries (Burgess #F4BP or equivalent).
3. Model 120PS/C	Power Supply: to convert Model 120CB to AC operation.

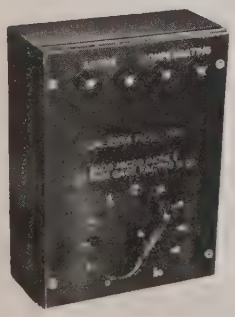


MODEL 220
PORTABLE STRAIN GAGE
SWITCHING UNIT

MODEL 230
SEMICONDUCTOR STRAIN
GAGE CONVERTER

MODEL 625
PRECISION CALIBRATOR

MODEL 225
PORTABLE SWITCHING
AND BALANCING UNIT



MODEL 250
CALIBRATION CHECK UNIT

Figure 1-2. Accessory Equipment

Table 1-2. Accessory Equipment

ITEM	USE	BLH #
Model 220 portable strain gage switching unit.	Switching up to 10 pairs of gages into indicator.	207321
Model 225 portable switching and balancing unit.	Switching and balancing up to 10 pairs of gages into indicator.	203791
Model 230 semi-conductor strain gage connector.	Enables use of semi-conductor gages with indicator.	207147
Model 250 calibration check unit.	Calibrator-troubleshooting.	103144
Model 625 precision calibrator.	Calibrator-troubleshooting	203797
Model 120 PS/C power supply.	Conversion of 120 CB to AC operation.	279468

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, repacking, and installation.

2-3. INITIAL INSPECTION.

2-4. Mechanical Inspection.

2-5. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the unit for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-8 for recommended claim procedure and repacking information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Retain the packaging material for possible future use.

2-6. Electrical Check.

2-7. Check the electrical performance of the instrument as soon as possible after receipt; see Maintenance, Section V of this manual, for the recommended performance checks. The checks will verify that the unit is operating within the specifications listed in Section I. This check is a good test procedure for incoming quality control inspection and for an operational check after repairs or adjustments have been made.

2-8. CLAIMS AND REPACKAGING.

2-9. Claims for Damage.

2-10. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest BLH Sales/Service Office (see list in back of manual). The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2-11. Repacking for Shipment or Storage.

2-12. If the instrument is to be shipped to a BLH Sales/Service Office, or to the factory, attach a tag showing owner, address, instrument model and serial number, and the repair required. The original shipping carton and packaging material may be reusable. The BLH Sales/Service Office will also provide information and recommendations on materials to be used if the original packaging material is not available or not reusable. Materials should include, (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly packed, shock absorbing material surrounding the instrument. Close the package securely with heavy paper tape.

2-13. INSTALLATION.

2-14. Location.

2-15. The indicator will operate satisfactorily between +30° F and +130° F (-1.1° C and 54 ° C) in most any environment. For best operation, however, avoid locations where the instrument will be subjected to temperatures above 110° F or below 32° F. The ideal location is a clean, dry, room with a uniform temperature.

2-16. Power Requirements.

2-17. The Model 120CA is designed to operate with a line voltage of 115 Vac, 50 - 60 Hz, at 4 watts. The Model 120CB is supplied with two 6-volt, F4BP weather-proof batteries. The batteries have been placed in plastic bags to protect the instrument against acid damage caused by accidental over-discharge. Power supply installation and conversion instructions for both the 120CA and 120CB Models of the INDICATOR are provided in Figure 2-2.

2-18. Power Cable.

2-19. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 120CA is equipped with a 10-foot, 3-conductor power cable; the third conductor is the ground conductor, and when the instrument is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three-prong connector is the ground connection. The other end of the cable is connected to the receptacle on the lower right side of the instrument.

2-20. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter, and connect the green lead on the adapter to ground.

2-21. STRAIN GAGE CONNECTION DATA.

2-22. Strain Gage Extension Leads.

2-23. Strain gage extension leads should have a low, stable, resistance and a minimum

temperature coefficient. The leads should be coated with an insulating material that is equivalent to the insulating quality of the gage carrier and bonding cements used. Table 2-1 lists materials that have been found suitable for BLH strain gage use.

Table 2-1. Gage Lead Conductors and Insulators

Conductors	Temperatures °F	
	Stable	Maximum
Nickel-clad copper	700	1000
Stainless steel-clad copper	800	1300
Nickel-clad silver	1000	1500
Nichrome	700	1700
Insulation	**Temperature Range**	
Nylon	Below -100°F	
Vinyl	-100 to 150°F	
Polyethylene	-100 to 200°F	
Teflon	-100 to 500°F	
Glass impregnated silicone	above 500°F	
Glass sleeving	above 500°F	

For other than BLH strain gages, consult the manufacturer.

2-24. All gage lead extension wires should be soldered or welded to the gages depending upon the application and type of gage used. For binding post connections, lead extensions should be soldered to clean, tinned spade lugs. If stranded lead-wire is used, all strands should be intact and care should be taken to solder all strands to the spade lug. In locations where strong electrical disturbances are present, shielded cable should be used for long extension leads. The shield should be grounded at only one point.

2-25. Lead Wire Resistance.

2-26. Lead wire resistance, in series with the strain gage, reduces the effective gage factor in proportion to the ratio of lead resistance to gage resistance. To correct this condition, it is necessary to reduce the gage factor setting on the instrument as follows:

Assume that a 120Ω strain gage, placed 50 feet from the instrument, has copper lead wires of #18 gage. The resistance of 18 gage copper is 6 ohms per 1000 ft., giving a total lead resistance of .6 ohms. Further assume that the compensating gage factor will be 0.6 or 0.5%. If the $\frac{}{120}$ true gage factor, as found on the gage package, is used, the indicated strains will be 0.5% low. Setting the gage factor on the instrument at 99.5% of the true gage factor will cause the instrument to automatically compensate for the lead-wire resistance. If, however, the lead-wire resistance exceeds 5% of the gage resistance, a more exact calculation is required.

2-27. SPECIFIC APPLICATIONS.

2-28. Two Arm - Four Wire.

2-29. To cancel the effects of temperature on the gage wire, a circuit like that shown in Figure 2-1 is used. The measuring or "active" gage is mounted on the test specimen and the compensating or "dummy" gage is mounted on an unstressed piece of the same material. Both gages are subjected to the same changes in temperature during the course of measurement. Resistance changes due to temperature alone will be the same for both of the Wheatstone Bridge arms in which these gages are located, (the remaining two arms are located within the instrument) and will not effect the stress-induced strain at the measuring gage. Connect the two measuring gage leads to the black and white terminals of the TWO ARM group of binding posts. Connect the two compensating gage leads to the green and white terminals of the TWO ARM group of binding posts. See Figure 3-4 for operating instructions.

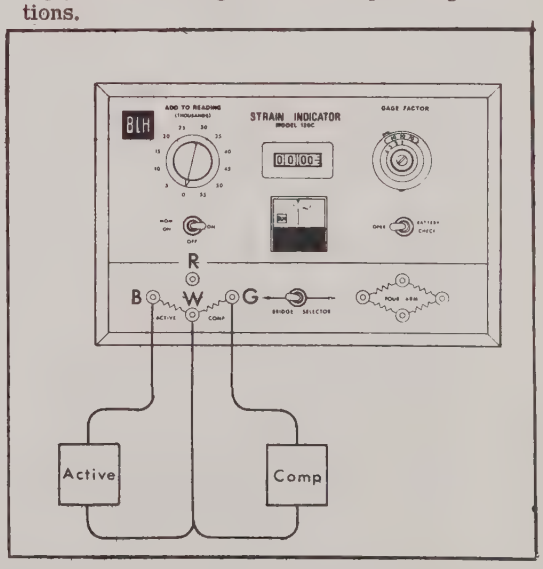


Figure 2-1. Two Arm-Four Wire Connections

NOTE

When half bridge configurations are connected to the instrument as shown in the diagrams, gages under compression loads will cause the null meter needle to deflect to the LEFT. Gages under tension loads will cause a RIGHT deflection of the needle.

CONVERSION INSTRUCTIONS
MODEL 120 C STRAIN INDICATOR

AC to DC

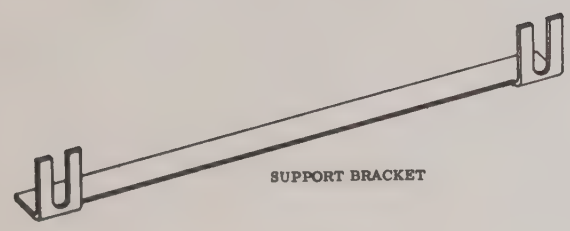
1. REMOVE THE TWO SCREWS ON THE REAR PANEL OF THE INSTRUMENT AND WITHDRAW THE CHASSIS FROM THE CASE.
2. TURN THE CHASSIS UPSIDE DOWN AND DISCONNECT THE FIVE COLOR-CODED POWER SUPPLY LEADS FROM THE TERMINAL STRIP.
3. LOOSEN THE TWO SCREWS HOLDING THE SUPPORT BRACKET AND REMOVE IT FROM THE CHASSIS.
4. REMOVE THE TWO SCREWS HOLDING THE POWER SUPPLY AND LIFT IT FROM THE POWER SUPPLY BRACKET.
5. PROCEED ACCORDING TO STEPS 2 4 5 AND 6 UNDER BATTERY INSTALLATION, BELOW.

DC to AC

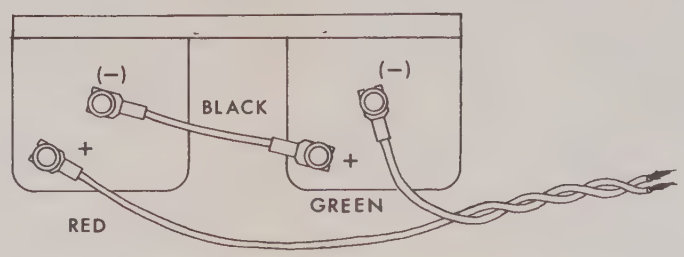
1. REMOVE THE TWO SCREWS ON THE REAR PANEL OF THE INSTRUMENT AND WITHDRAW THE CHASSIS FROM THE CASE.
2. TURN THE CHASSIS UPSIDE DOWN AND DISCONNECT THE GREEN AND RED BATTERY LEADS FROM THE TERMINAL STRIP.
3. LOOSEN THE TWO SCREWS HOLDING THE SUPPORT BRACKET AND REMOVE IT FROM THE CHASSIS.
4. LIFT THE BATTERIES FROM THE SUPPORT BRACKET AND REPLACE WITH THE MODEL 120 PS/C POWER SUPPLY.
5. SECURE THE POWER SUPPLY TO THE CHASSIS, NAMEPLATE UP, WITH THE TWO SCREWS PROVIDED AND REPLACE SUPPORT BRACKET.
6. CONNECT POWER SUPPLY CABLE TO TERMINAL STRIP, COLOR FOR COLOR, AND REPLACE CHASSIS IN CASE.
7. CHECK FOR PROPER INSTALLATION BY SWITCHING OPER/BATT. CHECK SWITCH TO THE BATT. CHECK POSITION. NULL METER SHOULD DEFLECT TO THE RIGHT PAST THE RED AREA.

BATTERY INSTALLATION

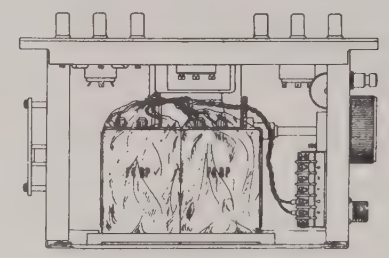
1. REMOVE THE TWO SCREWS ON THE REAR PANEL OF THE INSTRUMENT AND WITHDRAW THE CHASSIS FROM THE CASE.
2. CONNECT THE TWO 6 VOLT F4BP BATTERIES IN SERIES FOR 12 VOLT OPERATION USING THE JUMPER WIRES PROVIDED EXACTLY AS SHOWN.
3. TURN THE CHASSIS UPSIDE DOWN; LOOSEN THE TWO SCREWS HOLDING THE SUPPORT BRACKET, AND REMOVE IT FROM THE CHASSIS.



POSITION IN TRAY AFTER INSTALLATION



4. TIE THE PLASTIC PROTECTIVE BAGS CONTAINING THE BATTERIES AT THE TOP AND PRESS BATTERIES, NEGATIVE TERMINALS DOWN, INTO THE POWER SUPPLY TRAY. CONNECT THE RED LEAD TO TERMINAL R & THE GREEN LEAD TO TERMINAL G ON TB101.



5. REPLACE SUPPORT BRACKET SECURELY BEFORE SLIDING CHASSIS INTO CASE.
6. CHECK FOR PROPER INSTALLATION BY SWITCHING OPER/BATT. CHECK SWITCH ON FRONT PANEL TO THE BATT. CHECK POSITION. NULL METER NEEDLE SHOULD DEFLECT TO THE RIGHT PAST RED AREA.

Figure 2-2. Power Supply Conversion Instructions

2-30. Two Arm-Three Wire.

2-31. When it is desirable to connect the measuring and compensating gage together at the gages, rather than at the instrument, to form a three-wire half-bridge, connect the power lead of the measuring gage to the Black terminal, the power lead of the compensating gage to the Green terminal and the common or output lead to the White terminal as shown in Figure 2-3. See Figure 3-4 for operating instructions.

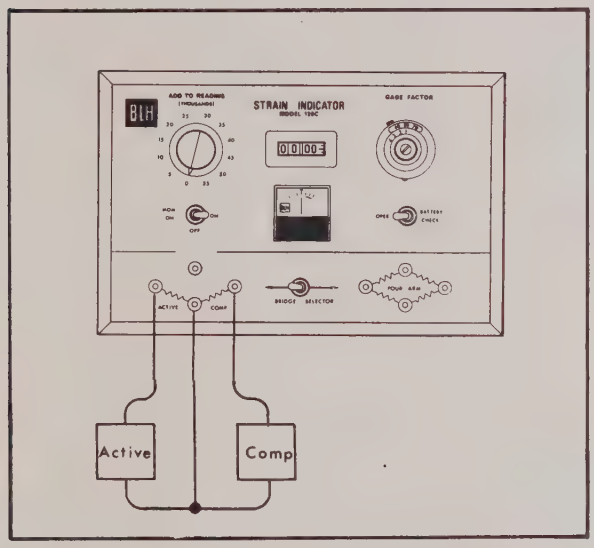


Figure 2-3. Two Arm-Three Wire Connections

2-32. Four-Arm.

2-33. In the four arm (full-bridge) configuration, four strain gages are connected in the form of a Wheatstone Bridge, any or all of which may be active. The user should determine the most practical arrangement from consideration of the problem at hand. It is only necessary to recognize that the bridge is unbalanced in proportion to the difference in the strains of active gages located in adjacent arms, and in proportion to the sum of the strains of active gages located in opposite arms. This arrangement has been used effectively where strains to be measured are very small. Connect the two input voltage leads to the Black and Green terminals and the gage bridge output leads to the Red and White terminals, as shown in Figure 2-4. See Figure 3-5 for operating instructions.

2-34. Three-Wire System With a Single Self-Compensated Gage.

2-35. Use of the self-compensated strain gage eliminates the need for a compensation gage in most cases. To avoid lead wire induced errors, BLH recommends that the "three-wire" method of resistance measurement be used. To use the three-wire system with the indicator, connect the gage to the instrument as shown in Figure 2-5. The resistor, R, should equal the gage G. See Figure 3-4 for operating instructions.

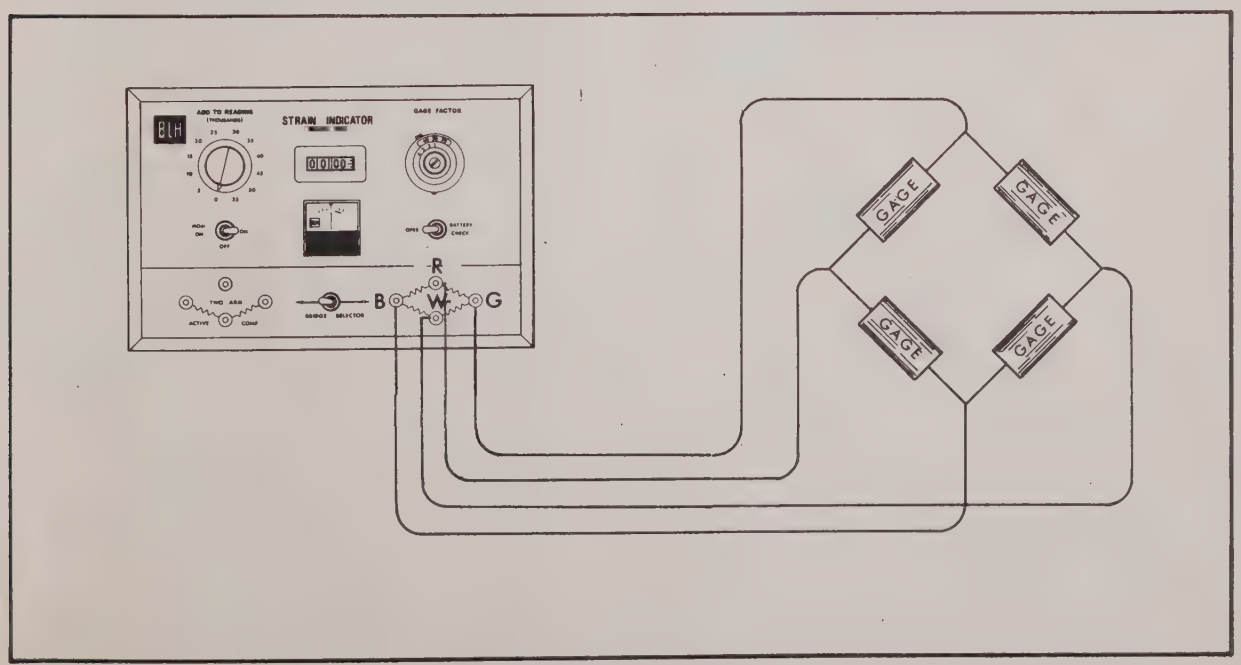


Figure 2-4. Four Arm Connections

2-36. Connecting and Switching Multiple Self-Compensating Gages.

2-37. Figure 2-6 shows a simplified connection and switching circuit for multiple self-compensating gage applications. The three wire system is used and the gages are located in close proximity to one another in order to minimize the temperature effects on the difference in lead wire lengths. The resistor, R , should be equal to one of the gages, G, and switch, S, must have a low, constant, contact resistance.

2-38. BLH has precision engineered and developed the Model 220 Portable Strain Gage Switching Unit and the Model 225 portable switching and balancing unit especially for this type of application. Both instruments, which are described in detail in Section I of this manual, may be used with any multiple strain gage application.

NOTE: When the Model 225 switching and balancing unit is used, the strain indicator must be calibrated through it. See Maintenance, Section V, of this manual for complete instructions.

2-39. Meter Instability with Multiple Gage Applications.

2-40. Under some circumstances, there is sufficient pick up in the gage wiring to cause a common-mode drift in the indicator when multiple gage applications are used. If the condition exists, it will usually become apparent by random displacement of the meter needle. In some cases, the meter will remain stable until the chassis is touched. To remedy the condition, reverse the gage leads at the Red and White terminals of the indicator. (To preserve polarity, the leads at

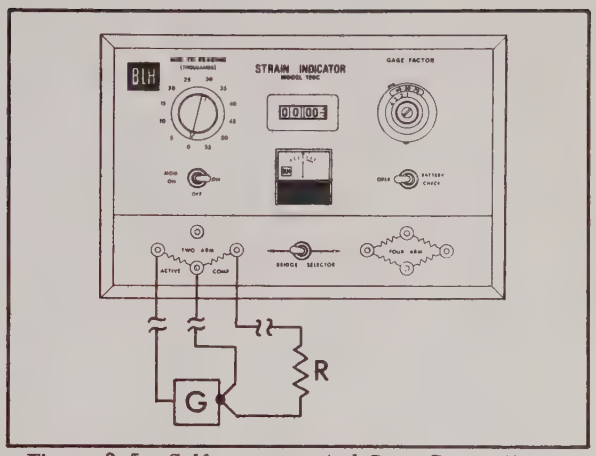


Figure 2-5. Self-compensated Gage Connections

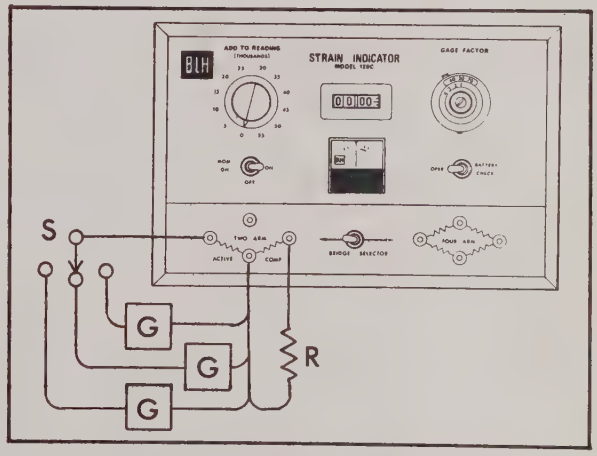


Figure 2-6. Switching Self-compensated Gages

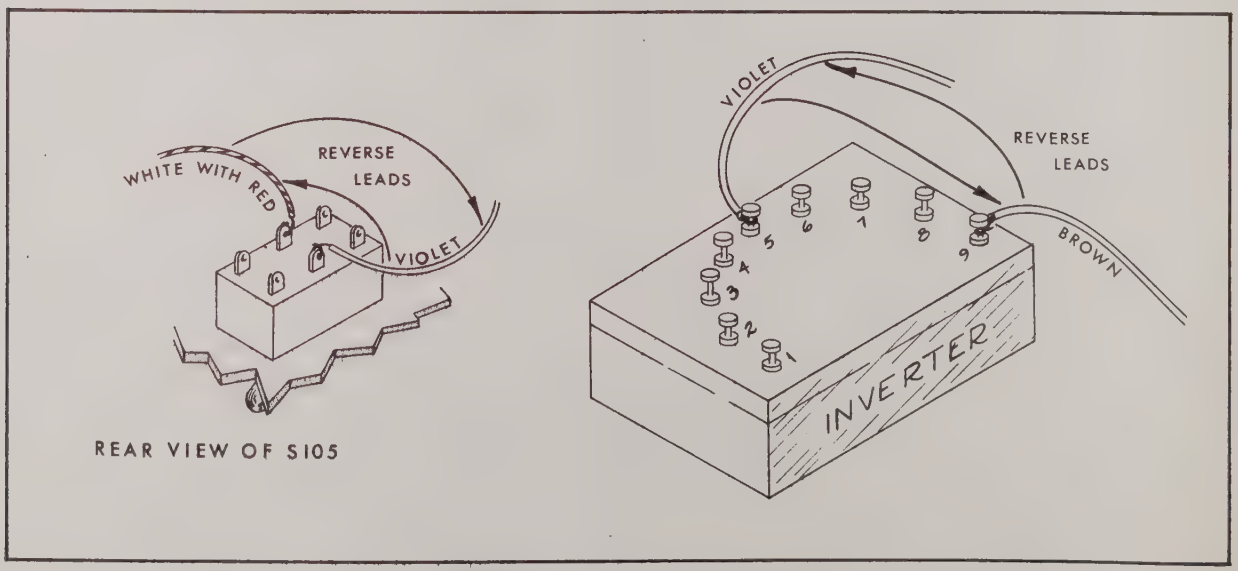


Figure 2-7. Polarity Reversal

the Black and Green terminals should also be reversed). A permanent change can be made by following the directions given in Figure 2-7.

2-41. Semi-Conductor Gage Applications.

2-42. Semi-conductor strain gages may be used successfully with the Model 120C in conjunction with the Model 230 Strain Gage Conditioner. The Model 230 has a unique circuit which allows the semi-conductor gage factor to be divided by 50 and the result dialed into the gage factor control on the indicator. Complete operating and gage installation instructions for semi-conductor gage use are detailed in the Model 230 operating and service manual.

2-43. Transducer Operation.

2-44. The indicator can be used to measure the response of any load or pressure transducer in the BLH line. The bridge circuits of these cells are adjusted to a standard output and are all fully compensated for temperature. Connect the transducer to the FOUR-ARM group of terminals color for color, as shown in Figure 2-8. See Figure 3-6, Section III, of this manual for operating instructions.

2-45. Front and Side Panel Control Data.

2-46. Controls used to operate the Model 120C are illustrated and explained in Figures 2-9 and 2-10.

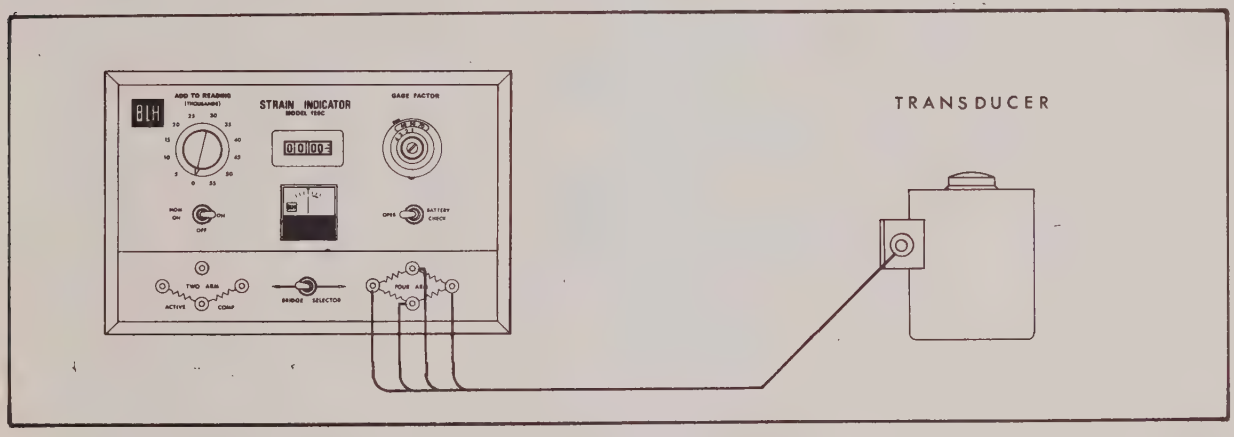
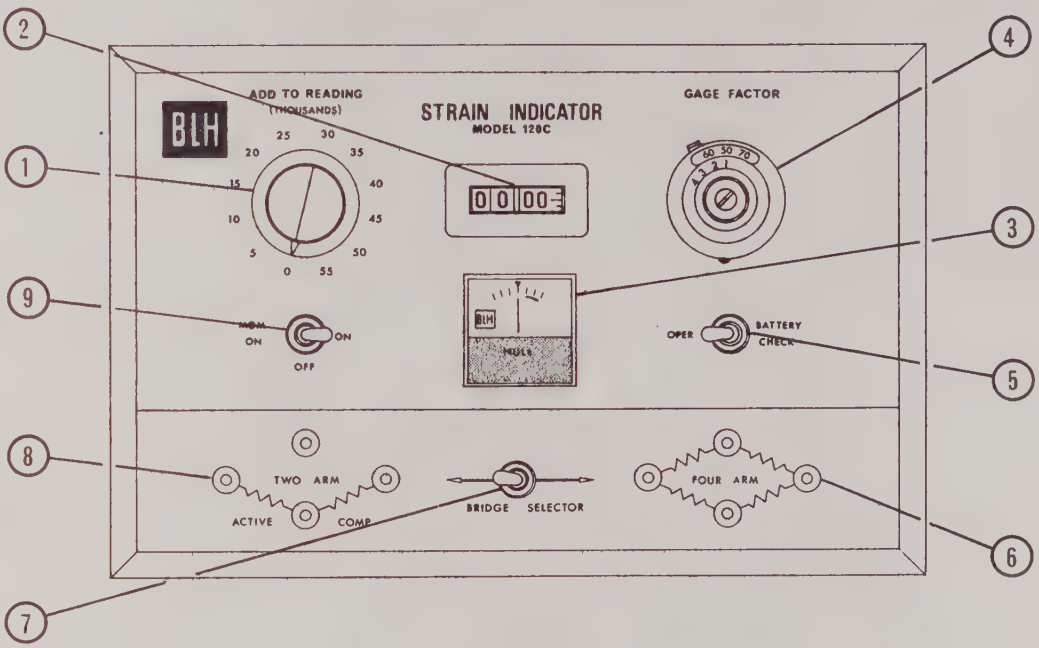


Figure 2-8. Transducer Connections



(1) ADD TO READING

Graduated from 0-55 in 5,000 microinch per inch steps, this switch shifts the reference point of the digital counter, increasing the range of the instrument. The switch is initially positioned at 30, (30,000 microinches per inch) the zero of the instrument, to provide an operating range of ± 30,000 microinches.

(2) Digital Counter

Used in conjunction with the ADD TO READING switch to indicate magnitude of strain. When null meter is balanced, counter reading is added to ADD TO READING switch setting. Readout is digital, in microinches.

(3) Null Meter

Indicates a balance between the strain gage bridge output and the measuring circuit output voltage. When the balancing control is rotated and the meter nulled at zero, the strain gage bridge output voltage equals the measuring circuit voltage. The meter has an approximate range of 50-0-50 microinches per inch.

Figure 2-9. Front Panel Control Data

CALIBRATED FOR OPERATION BETWEEN 1.5 & 4.5

(4) GAGE FACTOR.

The gage factor control is graduated from ~~1. 77 to 2. 20~~. When set to the factor corresponding to that of the gage in use, applies the proper voltage to the measuring circuit.

(5) OPER/BATT CHECK

Power supply self-check. When held in the BATTERY CHECK position the null meter pointer should deflect to the right past the red area. Used for both battery and ac operated instruments. For normal operation set the switch to OPER.

(6) FOUR ARM Terminal Posts.

For connection of strain gages wired into the full-bridge (four arm) configuration or transducer.

(7) BRIDGE SELECTOR

Position to the right toward FOUR ARM group of terminals for full bridge or transducer operation; position to the left toward two arm group of terminals for half-bridge (two arm) operation.

(8) TWO ARM terminal posts.

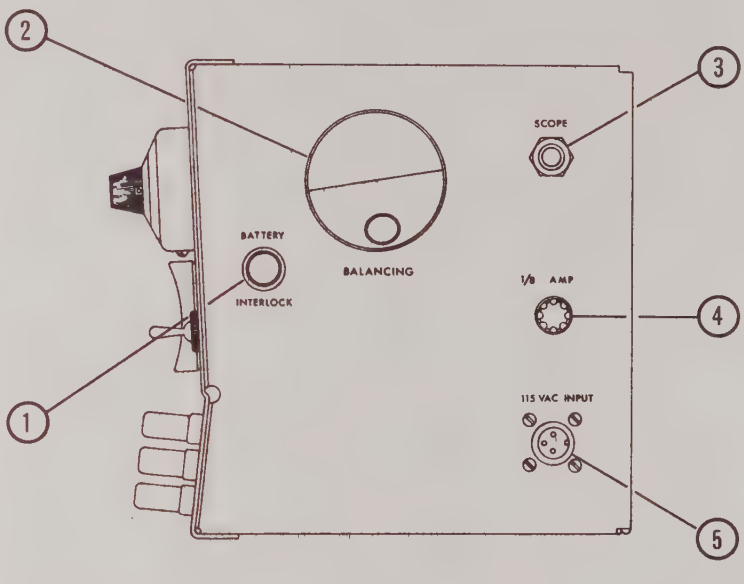
For connection of strain gages wired into a three or four-wire half-bridge configuration. When the BRIDGE SELECTOR switch is positioned for two-arm operation, two 500-ohm resistors are placed in the circuit completing, internally, a Wheatstone Bridge.

(9) MOM. ON/OFF/ON

Applies power to the indicator. When taking single intermittent readings with a battery operated instrument, hold the switch in the MOM. ON position to conserve battery life. For normal or ac operation, position the switch in the ON position.

Figure 2-9. Front Panel Control Data (Cont'd.)

SIDE PANEL CONTROL DATA



(1) BATTERY INTERLOCK

Disconnects instrument power when side door is closed to prevent battery discharge should power switch be inadvertently left on.

(2) Balancing Knob.

Geared to the slide wire and counter. When the control is rotated, it shifts the output voltage balance of the strain gage bridge (or transducer) and the measuring circuit. When exact balance occurs, the null meter indicates zero.

(3) SCOPE

Oscilloscope connection point for observation of dynamic strain.

(4) 1/8 AMP

Main power input fuse.

(5) 115 VAC INPUT

When the indicator is equipped with an ac power supply, the mating connector at the end of the input power cable is plugged into this connector. The ac power supply is protected by an independent 1/8 amp fuse located on the power supply chassis.

Figure 2-10. Side Panel Control Data

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. Operating Procedures.

3-3. Illustrations of the control panels and associated equipment, supported by text, describe the operating procedures presented in this section. The circled numerals on the controls are keyed to the step or steps in which the operation should be performed.

3-4. PRE-OPERATIONAL NOTES.

3-5. Indicator Zero.

3-6. Errors in instrument zero may be eliminated by the following methods.

TWO ARM METHOD

a. Connect a 120Ω precision wire wound resistor to the Black and White (ACTIVE) terminals of the two arm group of binding posts.

b. Connect a second 120Ω precision wire-wound resistor to the Green and White (COMP) terminals of the TWO ARM group of binding posts. Values of both resistances should be within .1% of each other (119.9-120.1Ω).

c. Place BRIDGE SELECTOR switch in the TWO-ARM position.

d. Balance the INDICATOR (see Figure 3-4) and record the reading.

e. Substitute the compensating gage resistor for the measuring gage resistor, rebalance the INDICATOR and record the reading. The sum of the two readings divided by 2 yields the true indicator zero.

NOTE

Two matched strain gages or two resistance decades meeting the specifications listed in Table 5-1, Section V, of this manual may be substituted for the 120Ω resistors.

FOUR ARM METHOD

To find true instrument zero with gages wired into a four arm configuration or with a transducer, proceed as follows:

a. Connect the two bridge power leads to the Black and Green terminals of the FOUR ARM group of binding posts.

b. Connect the two bridge signal output leads to the Red and White terminals of the four arm group of binding posts. (If a transducer is used, connect the cable to the FOUR ARM group of terminals color for color.).

c. Place BRIDGE SELECTOR switch in the four arm position. Balance INDICATOR (see Figure 3-5) and record reading.

d. Reverse leads at Red and White terminals, rebalance indicator and record reading. The sum of the readings divided by 2 yields the true indicator zero.

3-7. The computed zero may be used to correct all strain readings to the same basis and to take measurements during long tests. Measurements may also be taken on the same gages with different indicators without loss of accuracy.

3-8. Digital Counter Range.

3-9. The range of the digital counter can be increased appreciably - without changing the setting of the ADD to READING SWITCH - by introducing precision, non-inductive, wire wound resistors into the gage circuits as shown in Figure 3-1. This method is particularly useful when very large strains are to be measured. The circuit is determined by first choosing a convenient counter multiplying factor and then computing the value of the resistors to be added according to the formulas shown. To illustrate, assume that a counter multiplying factor of 4 is chosen. All strains would then be read as four times the value of the figure appearing in the digital display. With 4 then, as the multiplying factor, and assuming that the gages in use are 120Ω, the resistance values of R_1, R_2 and R_3 are computed as follows:

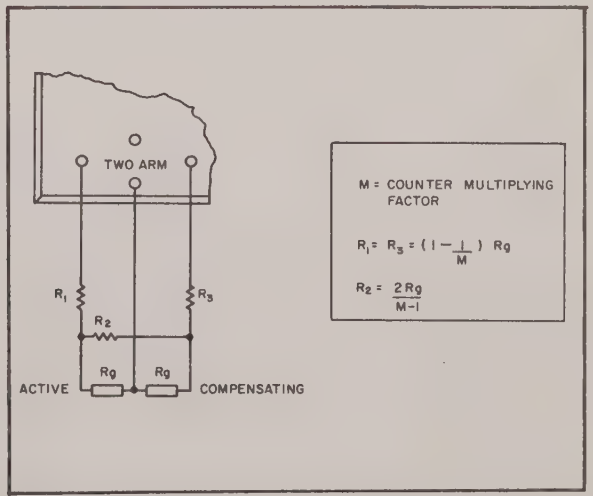


Figure 3-1. Increasing Range of Digital Counter

Find R_1 R_2 and R_3

Where: M = 4
Rg = 120Ω

1) $R_1 = R_3 = (1 - \frac{1}{M})\ Rg$

$R_1 = R_3 = (1 - \frac{1}{4})\ 120$

$R_1 = R_3 = (.75)\ 120$

$R_1 = R_3 = 90\Omega$

2) $R_2 = \frac{2\ Rg}{M-1}$

$R_2 = \frac{2 \times 120}{4-1}$

$R_2 = \frac{240}{3}$

$R_2 = 80\Omega$

3-10. Instrument Self-Check.

3-11. Both the battery and ac operated models of the strain indicator have been provided with a power supply self-check feature. Perform the check as described in Figure 3-3 before operating the instrument.

3-12. SPECIFIC APPLICATIONS AND OPERATION.

3-13. Two-Arm Operation.

3-14. The three or four wire method of strain measurement may be used with any two arm application. The gages are wired to the TWO ARM group of terminals and the BRIDGE SELECTOR switch placed in the TWO ARM position. See Figure 3-4 for operating instructions.

3-15. Four-Arm Operation.

3-16. Select gages with the same factors and set the gage factor dial to this figure. The gages are wired to the four arm group of terminals and the BRIDGE Selector switch placed in the four arm position. See Figure 3-5 for operating instructions.

3-17. Transducer Operation.

3-18. When measuring the output of BLH transducers, set the GAGE FACTOR dial of the indicator to 2.00 and calculate load by finding the "apparent strain" figure as shown in paragraph 3-21 (opposite). Divide this figure by 2000. The result will be the true millivolt per volt output of the transducer since 1mV/V will give a strain indication of 2000 microinches per inch. For example, a 5000 lb BLH C type load cell is factory adjusted to produce a 2.00 mV/V output at 5000 lbs of load. At full load, this cell would produce an "apparent strain" figure of 4000 microinches per inch. Divided by 2000, the result is 2.00 mV/V or the rated full scale output of the cell. See Figure 3-6 for operating instructions.

3-19. Visual Indication of Dynamic Strain.

3-20. Although the Strain Indicator has been designed primarily for the measurement of static strains, provisions have been made for the observation of dynamic strains with an oscilloscope. Connect the oscilloscope to the SCOPE jack located on the side panel of the indicator. If the magnitude of the strain to be observed is below 5000 microinches per inch, the indication is quantitative. Beyond 5000 microinches per inch, the amplifier of the INDICATOR becomes non-linear, and must be corrected for as shown in Figure 3-1. The use of this simple circuit will permit proportionately larger dynamic strains to be observed with good linearity. The plug used to connect the oscilloscope to the indicator should be a Switchcraft #40 or equivalent. Signal pick up will be as shown in Figure 3-2.

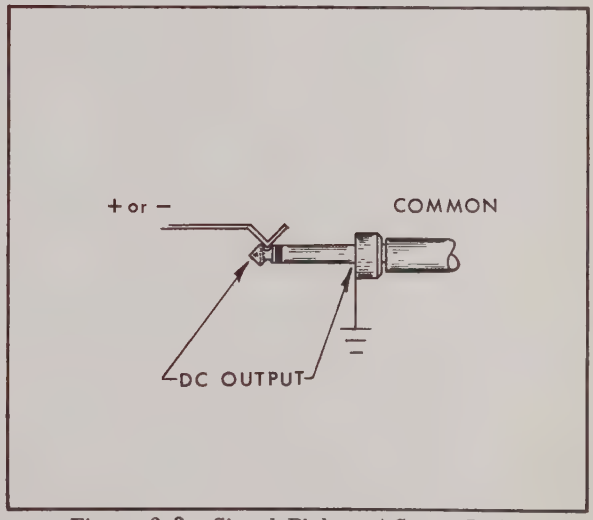


Figure 3-2. Signal Pickup at Scope Jack

3-21. Strain Calculation Formula.

3-22. Use the formula below to compute the magnitude of measured strain obtained in Figures 3-4 through 3-6.

$(T2 - T1)\ 1000 \times D2 - D1$

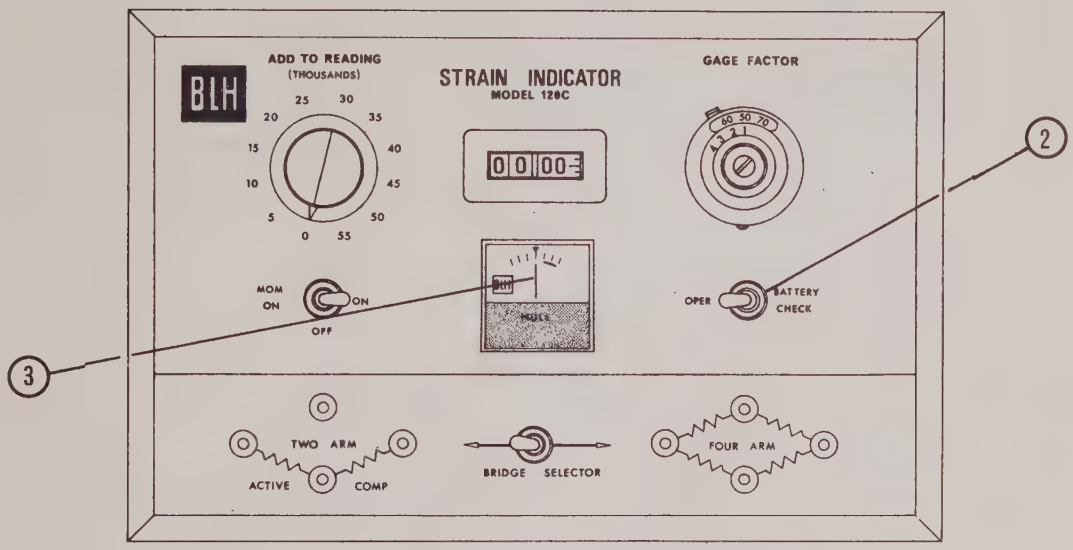
where:

T-2 = final add to reading switch setting.

T-1 = Initial add to reading switch setting.

D-2 = final counter reading.

D-1 = inital counter reading.



(1) Connect the instrument to a 115 Vac power source if the 120CA is being used.

(2) Place the OPER/BATT CHECK switch in the BATT CHECK position.

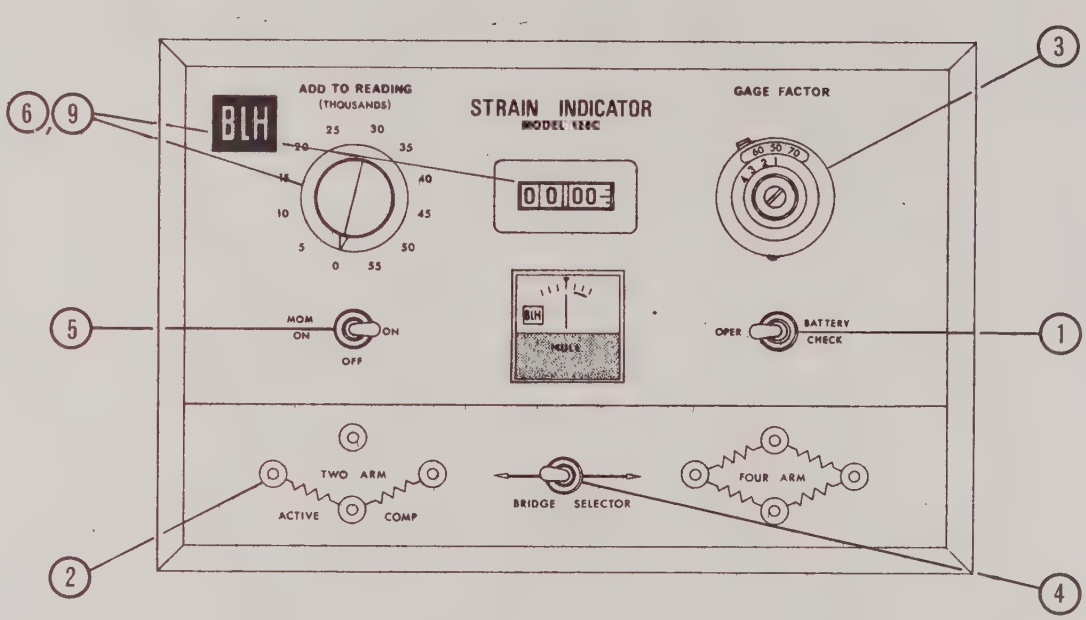
(3) The null meter pointer should deflect to the right, past the red area.

(4) If the pointer fails to move or stops in the red area, check the power cable connections, power supply or batteries, depending on the instrument in use.

(5) Repeat check hourly for battery operated instruments in continuous use. To conserve batteries, always switch power OFF when not actually taking readings.

Figure 3-3. Instrument Self-Check

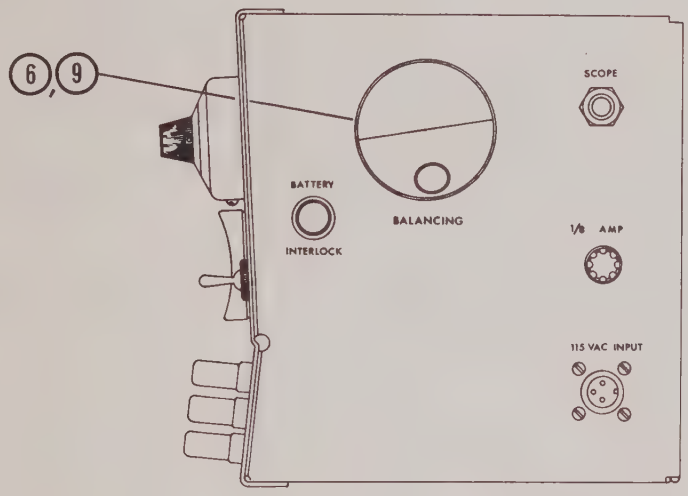
TWO ARM OPERATION



PRELIMINARY

1. Make instrument self check as described in Figure 3-3.
2. Select TWO ARM configuration desired and connect gages to TWO ARM group of terminals as described in Section II of this manual.
3. Set GAGE FACTOR control to exact value marked on gage package.
4. Place BRIDGE SELECTOR switch in TWO ARM position.
5. Switch instrument power ON.

Figure 3-4. Two Arm Operation



STRAIN MEASUREMENT

Initial Reading.

(6) Rotate balancing knob until meter pointer indicates zero. If pointer cannot be brought to zero, leave balancing knob at one end of travel (0 or 5000) and rotate ADD TO READING switch until pointer kicks across scale. Zero the meter.

(7) Record ADD TO READING switch setting and counter reading.

Final Reading.

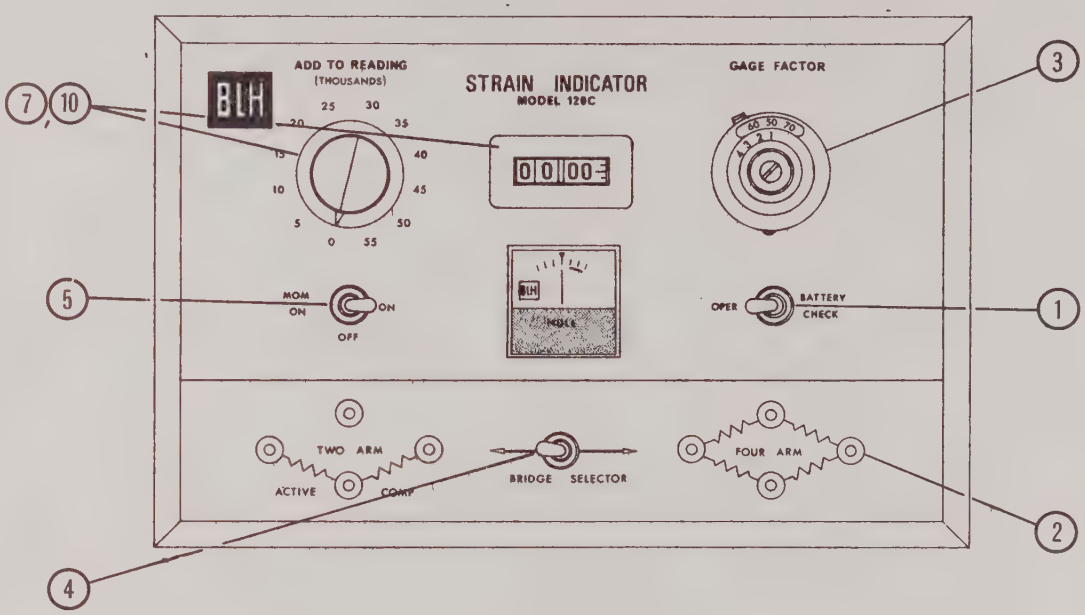
(8) Apply strain to gages.

(9) Repeat step 6.

(10) Record final counter and switch settings.

(11) Calculate strain according to instructions in paragraph 3-21.

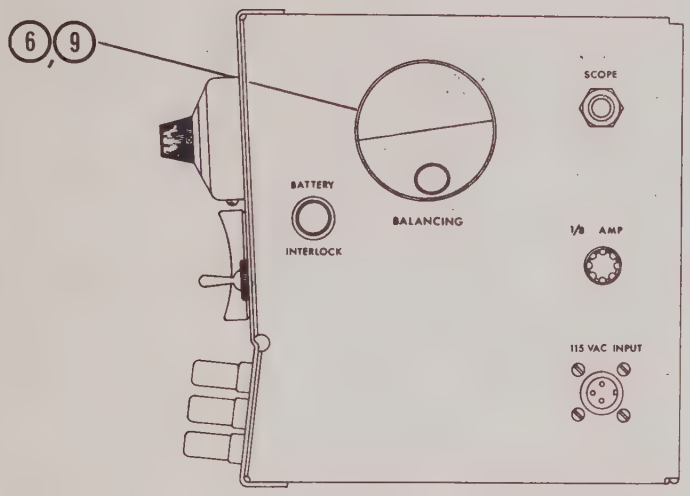
Figure 3-4. Two Arm Operation (Cont'd.)



PRELIMINARY

1. Make instrument self-check as described in Figure 3-3.
2. Select FOUR ARM bridge configuration desired and connect gages to FOUR ARM group of terminals as described in Section II of this manual.
3. Set GAGE FACTOR control to exact value marked on gage package.
4. Place BRIDGE SELECTOR switch in the FOUR ARM position.
5. Switch instrument power ON.

Figure 3-5. Four Arm Operation



STRAIN MEASUREMENT

Initial Reading.

(6) Rotate balancing knob until meter pointer indicates zero. If pointer cannot be brought to zero, leave balancing knob at one end of travel (0 or 5000) and rotate ADD TO READING switch until pointer kicks across scale. Zero the meter.

(7) Record ADD TO READING switch setting and counter reading.

Final Reading.

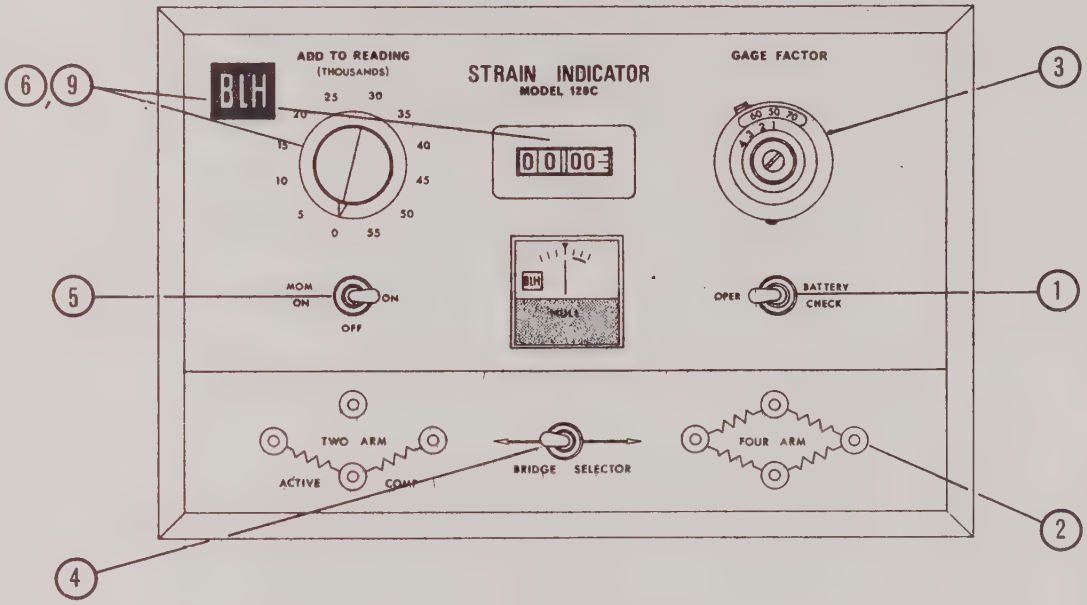
(8) Apply strain to gages.

(9) Repeat step 6.

(10) Record final counter and switch settings.

(11) Calculate strain according to instructions in paragraph 3-21.

Figure 3-5. Four Arm Operation (Cont'd.)



PRELIMINARY

(1) Make instrument self-check as described in Figure 3-3.

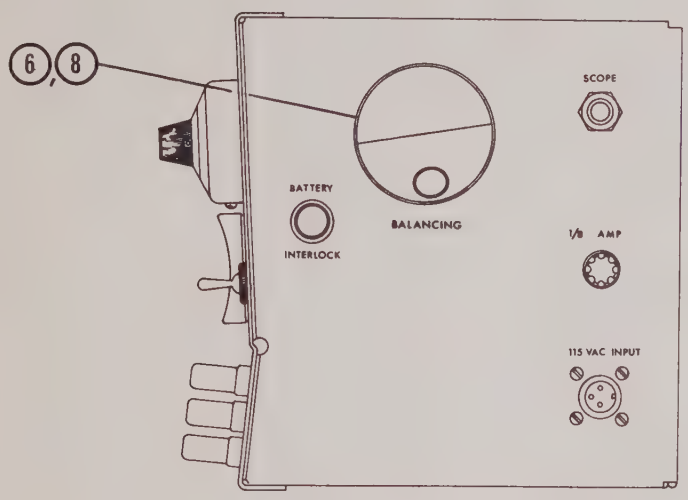
(2) Connect transducer to FOUR ARM group of terminals color for color.

(3) Set the GAGE FACTOR dial to 2. 00.

(4) Place BRIDGE SELECTOR switch in FOUR ARM position.

(5) Switch instrument power ON.

Figure 3-6. Transducer Operation



MEASUREMENT

Initial Reading.

(6) Rotate balancing knob until meter pointer indicates zero. If pointer cannot be brought to zero, leaving balancing knob at one end of travel (0 or 5000) and rotate ADD TO READING switch until pointer kicks across scale. Zero the meter.

Final Reading.

(7) Apply load to transducer.

(8) Repeat step (6).

(9) Record final counter and switch settings.

(10) Calculate load by finding the "apparent" strain as shown in paragraph 3-21. Divide this figure by 2000. The result will be the true millivolt per volt output of the transducer since 1 mV/V will give a strain indication of 2000 microinches per inch; 2mV, 4000, etc.

Figure 3-6. Transducer Operation (Cont'd)

OPERATING NOTES

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 120C Portable Strain Indicator is a null balance instrument designed to amplify, and convert to a digital readout in microinches, a change in voltage caused by resistance changes in strain gages. Strain gage excitation is accomplished by the inverter, which also provides a reference voltage to the demodulator, and excitation for the measuring circuit. The inverter and amplifier are powered by the 12 Vdc power supply. The strain gages are wired into a half or full Wheatstone Bridge, and are electrically balanced to equal the internal bridge of the instrument with no strain applied to the gages. When the gages are subjected to strain, the strain gage bridge becomes unbalanced, producing a signal which is fed to the amplifier and instrument measuring circuit. The demodulator compares this amplifed signal with the reference voltage from the inverter and produces a dc signal to the null meter. When the null meter is zeroed with the balancing knob, the strain on the gages is read out on the counter in microinches per inch. Refer to the block diagram, Figure 4-1, and the schematic diagrams in Section V of this manual.

4-3. CIRCUIT ANALYSIS.

4-4. Measuring Circuit.

4-5. The measuring circuit consists of two electrically connected bridges; a measuring bridge, of which the strain gages are a part, and an adjustable internal bridge. The two bridges are balanced prior to strain application by rotating the slide wire potentiometer, R125. As the gages are subjected to strain, the resistance of the gage bridge changes, resulting in an unbalanced condition as shown in the functional diagram, Figure 4-2. The voltage unbalance between the bridges at A and A' produces a signal which is applied to the input stage of the amplifier.

4-6. Amplifier.

4-7. The signal resulting from the bridge unbalance of the measuring circuit is applied to the input stage of the amplifier at pins 1 and 2 of the amplifier board. The amplifier provides a single ended input to the phase splitter, Q1. The signal is then amplified through two differential R-C coupled stages, Q2 and Q3, and Q4 and Q5. Q4 and Q5 operate as a push-pull pair of transistors applying the amplified signal to the demodulator.

4-8. Demodulator.

4-9. The amplified signal from the final stage of the differential amplifier energizes the primary winding of the coupling transformer, T-1, at the yellow and green leads. The voltage produced at the secondary winding of T-1 is applied to the diode bridge, CR3 through CR6, at the blue and brown leads. The

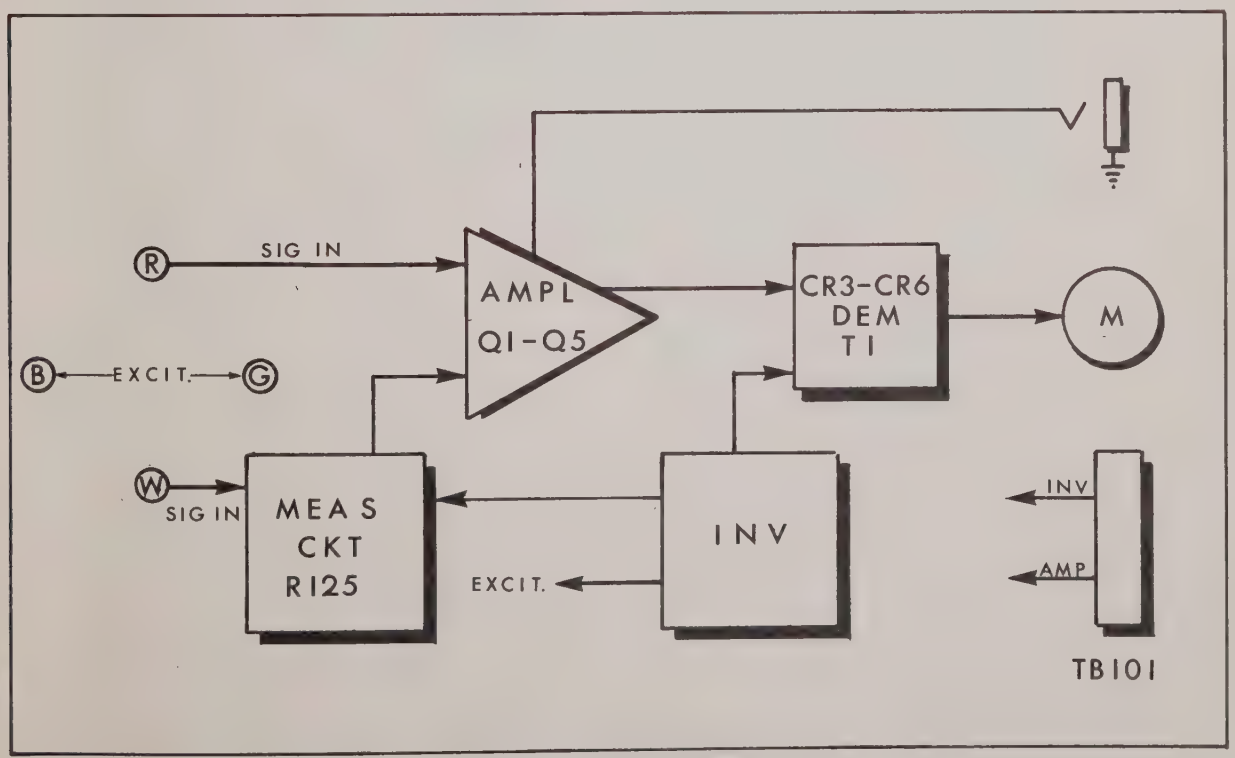


Figure 4-1. Block Diagram

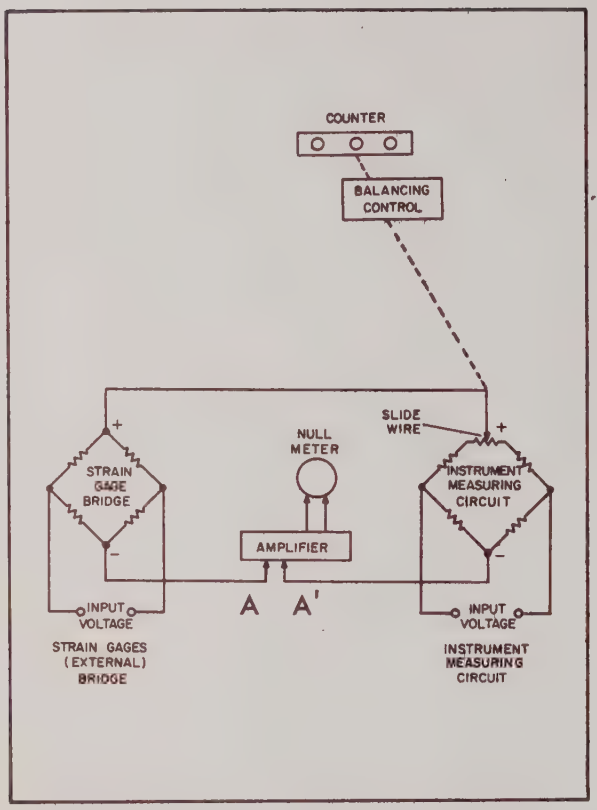


Figure 4-2. Null Balance, Functional Diagram

diode bridge acts as a pair of phase sensitive switches that compare the reference voltage from the inverter with the amplifier output, producing a dc voltage at pin 7 of the inverter to deflect the null meter.

4-10. Inverter.

4-11. The DC-AC inverter is an encapsulated unit containing a transformer and a pair of transistors wired into a parallel inverter configuration. The inverter is energized at pins 3 and 4 by the 12 Vdc power supply which causes the current to flow alternately through the two sides of the transformer producing a square wave ac voltage at approximately 1100 Hz at the secondary windings.

4-12. There are three separate voltages available at the secondary windings of the transformer. Pins 1 and 2 supply a 3 volt measuring circuit voltage, pins 5 and 9, the 3 volt strain gage bridge excitation voltage and pins 6 and 8 the demodulator reference voltage.

4-13. Power Supply.

4-14. The 12 Vdc power supply is provided by two 6V F4BP batteries in the Model 120CB and by a transformer/rectifier module, the Model 120PS/C, in the Model 120CA. 12 Vdc is taken from the red and green terminals of TB 101 to power the inverter, at pins 3 and 4, and the amplifier at the + and - terminals.

4-15. 115 Vac is applied to the primary winding of the 120 PS/C power supply transformer, T101, at the black and white terminals of TB 101. The output of the secondary is applied to the full bridge rectifier CR101. The output of the rectifier is filtered at C101 and C102, producing 12 Vdc at the red and green terminals of TB101. The four conductor shielded cable connecting the power supply to the instrument at TB 101, is grounded at the Y terminal.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance information for the Model 120C Strain Indicator. Performance checks, calibration, troubleshooting, and repair information are covered in this section.

5-3. Cover Removal.

5-4. The front cover of the INDICATOR is easily removed by lifting the latches located on the sides of the case. The cover will pivot outward from the bottom on the two half-hinges located on top of the instrument case.

5-5. PERFORMANCE CHECKS.

5-6. Performance checks, Table 5-2 , are designed to check the functioning of the instrument within specified tolerances. Performance checks can be used for incoming quality control inspection, to check performance after repair, or as an aid in troubleshooting.

5-7. Test instruments other than those listed can be used providing the performance equals or exceeds the critical Specifications. See Table 5-1 for recommended test equipment.

5-8. CALIBRATION.

5-9. The Strain Indicator measuring circuits are constructed of highly stable fixed and variable wirewound resistors and should give long dependable service without recalibration. If, however, a component should fail and is replaced or if, for other reasons, the calibration of the INDICATOR is in doubt, it may be checked and recalibrated with a BLH Model 625 Calibrator. The BLH Model 250 Calibration Check Unit may also be used to check the accuracy of the indicator. See Figure 5-1 for calibration procedures.

5-10. When the Indicator is used with the BLH Model 225 switching and balancing unit in the full bridge condition, with the bridge resistance selector in the 120 ohm position, one half of the active bridge is loaded down with approximately 8700 ohms. This shunt will cause a calibration error of approximately 3%. In the half bridge position, however, this resistance is not present and calibration will be unchanged. To minimize, or eliminate, the shunt resistance error in the full bridge position, calibrate the 120C INDICATOR with the switching and balancing unit in the circuit as described in Figure 5-1.

Table 5-1. Recommended Test Equipment

TYPE	CHARACTERISTICS	PURPOSE	RECOMMENDED
Calibrator	Output accuracy at each point 0.1% or ± 0.0003 mV/V which ever is greater.	Performance check and troubleshooting	BLH Model 625 Precision Calibrator
AC/DC VTVM	1 mV to 100 V, 10 megohm impedance.	Performance check and troubleshooting	
Decade Resistor	Total resistance, 10,000 ohms, multiple of 1 ohm .05% accuracy.	Performance check and troubleshooting	
Multimeter	± 1% accuracy at full scale input impedance 200 megohms.	Troubleshooting	
Oscilloscope	200 kHz bandwidth	Troubleshooting	
Signal Generator	Continuously variable 0 to 1200 Hz, sine wave, 500 mV output.	Troubleshooting	
Variable Power Transformer	0-230 Vac	Performance check	

Calibration With Model 625.

Preliminary: Perform the instrument self-check as described in Figure 3-3, Section III of this manual before attempting these procedures.

1) Connect the four arm group of terminals on the INDICATOR to the 120Ω group of terminals on the calibrator color for color as shown below.

2) Position CALIBRATOR controls as follows:

BRIDGE SELECTOR	120Ω
Range	0-10
Step	0

Position INDICATOR controls as follows:

BRIDGE SELECTOR	Four Arm
Gage Factor	2.00
Add to Reading	30
Power	ON

3) Zero the INDICATOR and record reading.

4) Set STEP switch of the Calibrator to 1 mV/V.

5) Rebalance INDICATOR and record reading.

6) Continue sequence in 1 mV/V steps through 10 mV/V recording the reading at each step.

7) Compute each value per strain calculation formula (Paragraph 3-22).

8) Reverse black and green leads at Calibrator and repeat sequence.

9) Readings should be ± 50 microinches per inch at 20,000 microinches per inch. Should check reveal errors of less than 100 microinches per inch, adjust gage factor controls described in Paragraph 5-21, Gage Factor Range Adjustment.

Calibration Through Model 225.

1. Connect the Model 625 calibration unit to the Number 1 channel input terminals on the rear of the Model 225 Switching and Balancing Unit.
2. Connect the four arm group of terminals on the 120C Strain Indicator to the OUTPUT terminals of the Model 225, color for color.
3. Connect the R' terminal of the Model 225 to the red terminal in the TWO ARM group of terminals on the Model 120C.
4. Position the CALIBRATOR Controls as follows:

Bridge Selector	120Ω
Range	0-10
Step	0

5. Position the INDICATOR controls as follows:

Bridge Selector	Four Arm
Gage Factor	2.00
Add to Reading	30
Power	ON

6. Position the Balancing Unit controls as follows:

Input Bridge	◇
Gage Resistance	120
Channel Selector	1

7. Turn 120C INDICATOR balancing knob until counter indicates 0000.
8. Null meter of 120C with Channel 1 ZERO ADJ control on Model 225 balancing unit.
9. Proceed with calibration, exactly as described above with 625 calibrator.
10. After calibration is completed, disconnect 625 calibrator and connect four-arm strain gage bridge or transducer to CHANNEL 1 input terminals for measurement.

IMPORTANT

INDICATOR must be recalibrated before using with other applications.

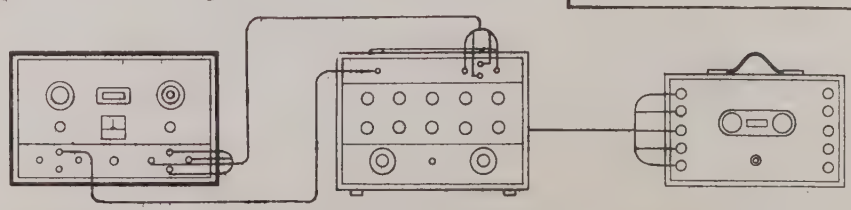


Figure 5-1. Calibration Procedures

5-10. ADJUSTMENTS.

5-11. Preliminary.

5-12. Adjustments are made when the Performance Checks indicate such adjustments are necessary or as a result of replacing components. The calibration adjustment as described in the following paragraph is the only external adjustment and is made when indicated by the calibrator check, Figure 5-1. All other adjustments are made at the trim pots located on the measuring circuit board, Assy. A-3, and on the amplifier board, Assy. A-1.

5-13. Calibration Adjustment.

5-14. Should the calibration check, Figure 5-1, reveal errors of more than 50 but less than 100 microinches per inch at a 20,000 microinch per inch load, it can be corrected as follows:

a. Release dial lock and loosen the Allen-head set screw located within the gage factor knob.

b. Loosen the small round-head slotted set screw located on the bottom of the counter assembly.

c. Remove the entire counter and gage factor knob assembly from the gage factor potentiometer shaft. It may be necessary to pry the assembly loose by gently working around the edge with a screw driver. After removing the counter, polish the shaft with a jeweler's file until a smooth sliding fit is obtained.

d. Apply the equivalent of 20,000 microinches per inch (10 mV/V) of strain to the indicator with a BLH Model 625 Calibrator.

e. Rotate the gage factor potentiometer shaft until the indicator reads 20,000 microinches per inch ± 20 microinches per inch.

f. Set the counter assembly to 2.00 and tighten the large slotted screw on the gage factor knob.

g. Carefully slide the counter assembly onto the shaft, without disturbing the null meter setting.

h. Tighten the set screws and loosen the large slotted knob screw until the counter turns freely.

5-15. Internal Adjustments.

5-16. There are two internal electrical and one mechanical adjustment on the Model 120C: amplifier balance, (meter sensitivity) and gage factor range adjustments and the mechanical zero adjustment. Unfasten the two screws on the rear panel of the instrument and withdraw the chassis from the case. Place the instrument on an insulated surface. All controls are easily accessible; it is not necessary to dismount the etched circuit boards.

5-17. Mechanical Zero Adjustment.

5-18. If the slidewire potentiometer (R125) or if any of the mechanical components of the counter drive mechanism require replacement, it will be necessary to reset the mechanical zero of the digital counter as follows:

a. Remove the snap ring from the shaft of the idler gear - the center spur gear of the counter gear train - and slide it off the shaft.

b. Turn the slidewire potentiometer shaft fully counterclockwise.

c. Manually set the counter to 6 microinches below 0000.

d. Without disturbing the settings of the counter and slidewire potentiometer, slide the idler gear onto the shaft and replace the lock ring.

5-19. Meter Sensitivity Adjustment.

5-20. If the performance check indicates low meter sensitivity, adjust as follows:

a. Set GF at 2.00, /Add to reading at 30/power ON.

b. Short circuit input terminals 1 and 2 of the amplifier board, Assy. A-1, with a jumper wire. Connect a D.C. voltmeter across the collectors of Q2 and Q3.

c. Adjust R-10 until the measured voltage is less than 0.05 Vdc.

d. Remove the jumper wire and voltmeter and recheck meter sensitivity.

5-21. Gage Factor Range Adjustment.

5-22. If the gage factor or slide wire potentiometer becomes defective, after replacement it will be necessary to reset the gage factor range of the instrument.

Mechanical Adjustment

a. Turn the gage factor control fully counterclockwise. At the end of travel, the counter should indicate 1.5.

b. If the counter does not indicate 1.5, remove

the counter assembly from the potentiometer as described in paragraph 5-14.

c. Set the counter to 1. 5 and with the gage factor potentiometer shaft fully counterclockwise, slide the assembly onto the shaft, and tighten the set screws and proceed with the electrical adjustment.

Electrical Adjustment

a. Connect a BLH Model 625 calibrator, 120Ω side, to the four arm group of binding posts color for color.

b. Position the indicator controls as follows:

Gage Factor	-	2.00.
Add to Reading	-	30
Power	-	ON
Bridge Selector	-	Four-Arm

c. Position the calibrator controls as follows:

Range Switch	5 mV/V
Bridge Selector	120 ohms
Step Switch	0 mV/V

d. Position the three 20 turn trim pots R107 (GF2), R102 (GF4) and a 109 (SW) to center of travel.

e. Null meter with balancing knob.

f. Turn ADD to READING switch to 25, and set digital counter to 5000. Split the difference between the null meter pointer and the center graduation with the SW pot.

g. Return counter to 0000 and turn ADD to READING switch to 30.

h. With the calibrator, apply the equivalent of 5000 microinches (2. 5 mV/V) to the indicator and NULL meter with the GF2 pot.

NOTE

If meter cannot be nulled with the gage factor trim pots, the select resistor, R1-3, will have to be replaced at the factory.

CHANGE TME-1200-3-2

* i. ~~Return digital counter to zero and set~~ gage ~~factor to 4. 00.~~ SENTENCE IS OK

j. ~~Apply 4 mV/V to the indicator with the 625 calibrator.~~

l. NULL meter with GF4 pot.

m. Disconnect calibrator and replace instrument in case.

CAUTION.

The gage factor counter assembly has been set to indicate between 1. 5 and 4. 5 only. Do not attempt to turn the control past these points.

Table 5-2. Performance Checks.

POWER SUPPLY VOLTAGE CHECK.

Self-Check:
Place OPER/BATT CHECK switch in the BATT. CHECK position, Null meter pointer should deflect to the right past the red area.

FREQUENCY AND BRIDGE EXCITATION CHECK.

Refer to Figure 5-2 for test set up.

a. Connect a BLH Model 625 calibrator to the Four Arm group of terminals, color for color, to simulate a load.

b. Monitor the bridge excitation voltage at the black and green terminals with an oscilloscope meeting the specifications in Table 5-1. Bridge excitation should be between 2. 75 and 3. 25 Vac at 1000 Hz (square wave).

NULL METER SENSITIVITY CHECK

This is a check of the amplifier gain and is performed as follows:

a. Connect a 120 ohm resistor across the white and green COMP. terminals of the two arm group of binding posts.

b. Connect a second 120 ohm resistor across the black and white ACTIVE terminals of the two arm group of binding posts.

c. Set gage factor control to 2. 00 and ADD to reading switch on 30.

d. Rotate balancing knob until NULL meter

indicates zero and record reading.

e. Rotate balancing knob until NULL meter deflects to the third meter division either side of zero balance. Record reading.

f. Find difference between two readings. Difference should be between 30 and 45 microinches per inch.

METER DEAD SPACE CHECK.

Use same test set up as for Null Meter Sensitivity Check and proceed as follows.

a. Rotate balancing knob until meter indicates zero.

b. Rotate balancing knob. Null meter should deflect slightly left or right when counter is moved 2 microinches.

DYNAMIC STRAIN RANGE CHECK.

Refer to Figure 5-3 for test set up.

a. Connect a BLH Model 625 Calibrator to the FOUR ARM group of terminal posts on the indicator color for color.

b. Set the indicator and calibrator controls as follows:

Calibrator

Range Switch	-	0-5
Bridge Selector	-	120Ω
Step Switch	-	0

Indicator

Gage Factor	-	2. 00
Add to Reading	-	30
Power	-	ON
Bridge Selector	-	Four Arm

c. Connect the strain indicator scope jack to an oscilloscope meeting the specifications listed in Table 5-1.

d. Apply power to both the indicator and the oscilloscope.

e. Set oscilloscope vertical sensitivity and horizontal sweep for suitable square wave ac display at 1 mV/V.

f. Balance the indicator with the calibrator at zero and adjust scope trace to indicate desired zero point.

g. Apply 5000 microinches per inch of strain (2. 5 mV) to the indicator with the calibrator.

h. Scope should indicate 100 mV/V ± 0. 1V.

COUNTER LINEARITY CHECK.

a. Connect a BLH Model 625 calibrator, 120Ω side, to the indicator color for color.

b. Set the indicator controls as follows:

Gage Factor	-	2. 00
Add to Reading	-	30
Power	-	ON
Bridge Selector	-	Four Arm

c. Set the calibrator controls as follows:

Range Switch	-	0-1
Step Switch	-	0
Bridge Selector	-	120Ω

d. Balance the indicator and record reading.

e. Apply . 10 mV/V of strain to the indicator balance and record reading. Reading should be 500 microinches per inch ± 5 microinches per inch.

f. Continue sequence according to performance check test card, page 5-7, up to and including 2. 5 mV/V.

ZERO DRIFT AND STABILITY CHECK.

a. Connect a BLH Model 625 calibrator, 120Ω side, to the indicator, color for color.

b. Set indicator controls as follows:

Gage Factor	-	2. 00
Add to Reading	-	30
Power	-	ON
Bridge Selector	-	Four Arm

c. Set calibrator controls as follows:

Range Switch	-	0-1
Step Switch	-	0
Bridge Selector	-	120Ω

d. Balance indicator and record reading.

e. Leave set-up for one hour at 70 ° F.

f. Rebalance indicator and record reading. Difference between this reading and reading obtained in step d, above, should be ± 5 microinches per inch.

LINE REGULATION CHECK. (Model 120CA only)

a. Apply line power to the indicator through

Performance Checks. Table 5-2 (cont'd.)

a variable power transformer. (VARIAC).

b. Connect a BLH Model 625 calibrator to the four arm group of terminals on the indicator, color for color.

c. Monitor the Bridge Excitation Voltage at the black and green terminals of the indicator with an ac voltmeter. It should be possible to vary the power source voltage ± 10% (103-127 volts at 115 Vac) and maintain the bridge excitation voltage between 2.75 and 3.25 Vac.

INTERLOCK CHECK. (Model 120CB)

a. Open side door of indicator. Place the OPER./BATT CHECK switch in the BATT CHECK position. NULL meter pointer should deflect to the right past the red area. Hold switch in this position.

b. Close side door. Null meter pointer should return to zero.

5-23. POWER SUPPLY AND BATTERY INSTALLATION.

5-24. The Model 120 C is operated from a 12Vdc power supply. The Model 120C comes equipped with a rectifier/filter module that steps down and rectifies a line voltage of 115Vac to 12Vdc. The Model 120CB, the battery operated model of the indicator, is operated from a 6 Vdc source supplied by 2 F4BP 6V batteries wired in series. Installation and conversion instructions for both models are detailed in Figure 2-1. See Figure 5-5 for a schematic diagram of the Model 120 PS/C power supply circuit.

5-25. TROUBLESHOOTING AND REPAIR.

5-26. Preliminary.

5-27. The basic tools for troubleshooting the indicator are the schematics, theory information in Section IV and the checks and adjustments listed in this section.

5-28. To locate trouble in the indicator, start with a thorough visual inspection and proceed to electrical checkout as necessary. During the visual inspection look for loose components, loose wire connections or similar conditions which would indicate a trouble source. Repair any faulty component or connection that is discovered during the visual inspection and check instrument performance before continuing the troubleshooting process.

5-29. If no obvious fault is located during the visual inspection, proceed with the electrical checkout. Use the block diagram in Section IV and the voltages provided on the schematic diagram as aids in isolating the trouble to a particular circuit.

5-30. Attempt to isolate the malfunction to one or more of the following units of the indicator in the order listed: power supply, inverter, amplifier, measuring circuit board and ADD to READING switch.

5-31. Transistor Replacement.

5-32. Transistors are inherently long-lived devices and should be replaced only when indicated as faulty. Do not check soldered-in transistors by substitution as the transistor or circuit board may be damaged. Leakage current from the soldering iron or a momentary short can permanently damage a transistor.

5-33. Refer to paragraph 5-33 before attempting to replace a transistor, then use a hot 50 watt or smaller iron. Apply heat to the leads of part to be replaced, NOT to the printed circuit on the board. Clean holes before installing the new transistor. Use long-nose pliers as a heat sink between the iron and transistor. Allow the transistor to cool before applying power to the unit.

5-34. Servicing Etched Circuit Boards.

5-35. Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low-power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick-drying acetate base cement having good electrical insulating properties. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer. When replacing components with multiple mounting pins such as transistors, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the component several times until it is free.

a. Apply heat sparingly to lead of component

PERFORMANCE CHECK TEST CARD

DESCRIPTION	CHECK
FREQUENCY AND BRIDGE EXCITATION CHECK Connect calibrator to indicator (four arm), monitor ac voltage at BLK and Grn terminals with scope.	Vac [ ] Should be between 2. 75-3. 25 Hz [ ] Should be 1000 Hz ± . 1 Hz
NULL METER SENSITIVITY CHECK Connect 120Ω half-bridge to two arm group. Balance indicator, record reading. Rotate balancing knob until meter deflects to third division, record reading.	Microinches [ ] First Reading - microinches per inch. [ ] Second Reading - microinches per inch. [ ] Difference - should be between 30 and 45 microinches per inch.
METER DEAD SPACE CHECK Connect 120Ω half-bridge to two arm group. Balance meter, record reading. Rotate balancing knob until meter pointer moves off null, record reading.	Microinches [ ] First Reading - microinches per inch. [ ] Second Reading - microinches per inch. Should be with 2 microinches of first reading.
DYNAMIC STRAIN RANGE CHECK Connect 625 calibrator to four arm group. Connect scope to scope jack. Balance indicator at zero. Apply input signal of 2. 5 mV/V.	Actual [ ] Oscilloscope should indicate 100 mV/V ± 0. 1V at 2. 5 mV/V.
COUNTER LINEARITY CHECK Apply signals with calibrator. Add to reading switch at 30. Actual reading should equal counter reading at mV/V setting indicated, ±5 microinches per inch.	Actual [ ] . 25 500 [ ] . 50 1000 [ ] 1. 00 2000 [ ] 1. 50 3000 [ ] 2. 00 4000 [ ] 2. 50 5000
ZERO DRIFT CHECK. Measure at 70° F, zero signal. Add to reading set at 30.	[ ] Initial Reading [ ] Final Reading [ ] Difference = Drift ±5 microinches/hour
LINE REGULATION CHECK (Model 120CA only) Apply line power to instrument through Variac. Connect 625 calibrator to FOUR ARM group. Take reading across black and green terminals of FOUR ARM group.	Actual [ ] Black to Green voltage at 103 Vac 2. 75-3. 25. [ ] Black to green voltage at 127 Vac 2. 75-3. 25

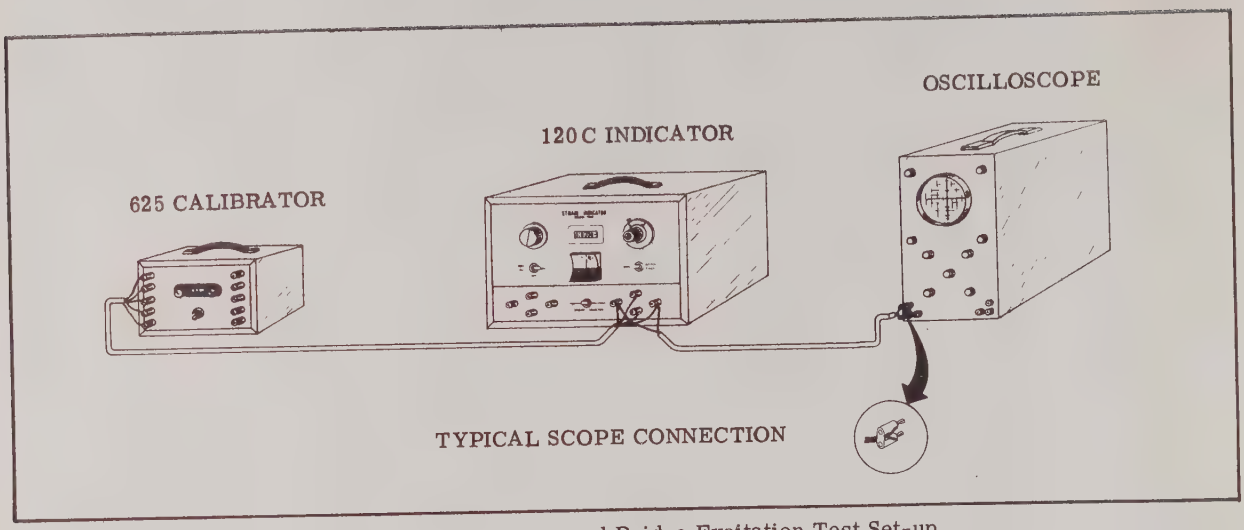


Figure 5-2. Frequency and Bridge Excitation Test Set-up

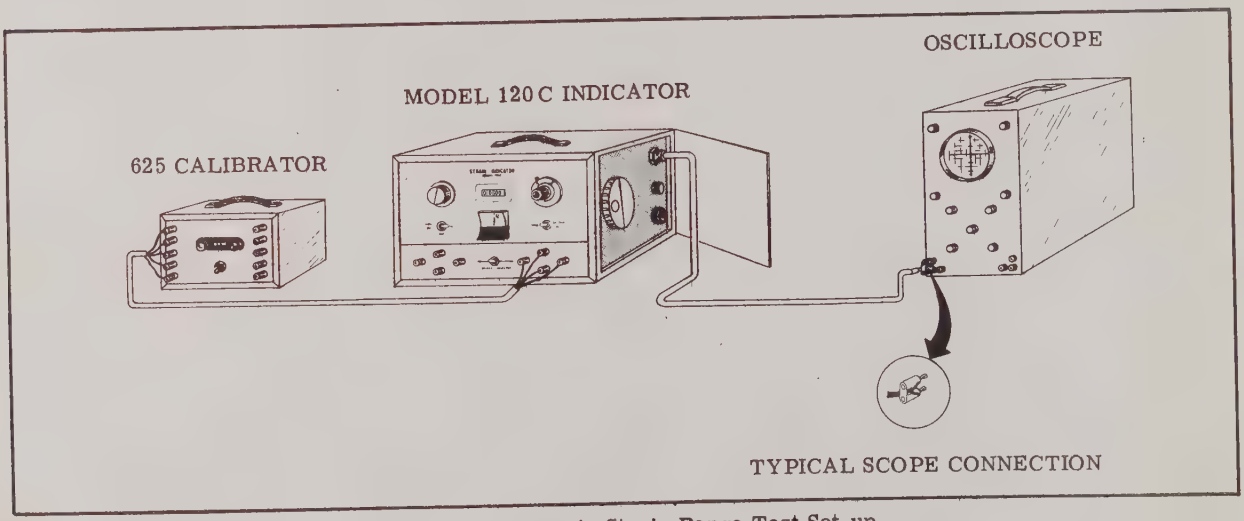


Figure 5-3. Dynamic Strain Range Test Set-up

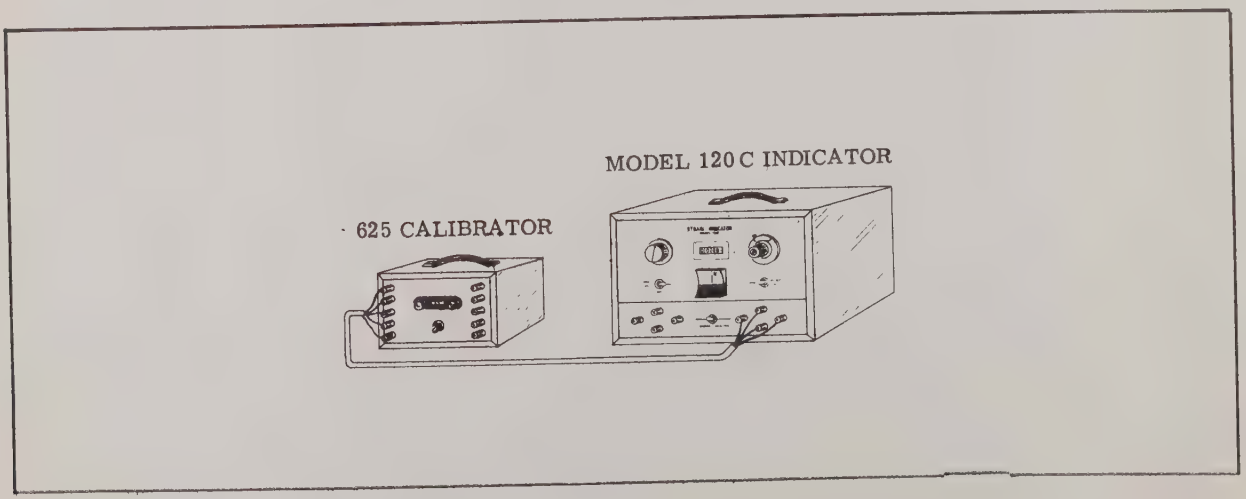


Figure 5-4. Linearity, Drift, and Stability Test Set-up

to be removed. If lead passes through an eyelet in the circuit board, apply heat on the component side. If lead does not pass through an eyelet, apply heat on the conductor side of the board.

b. Reheat solder in vacant eyelet and quickly insert a wood sliver or toothpick to clean inside of hole.

c. Bend clean tinned leads on new component and carefully insert through eyelets or holes on board.

d. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 'a' above.

e. If the steps above are impractical or if the board has been damaged, clip the leads of the component to be removed close to the part itself leaving as long leads as possible still soldered to the board.

f. Straighten old leads and bend leads of new part around the protruding leads. Apply solder using a pair of long-nose pliers for a heat sink

5-36. Troubleshooting Procedure.

5-37. Check the power supply as follows: Perform instrument self-check. If null meter pointer stops in red area, and the Model 120 CB instrument is being used, replace the batteries. Check the Model 120 CA power supply with a dc voltmeter. The voltage across terminals G (-) and R (+) of the barrier strip should be approximately 12 volts. If the DC voltage at this point is zero, use an ac voltmeter to check the line voltage across terminals B and W. A reading of 115 Vac at this point and zero at terminals G and R indicate a faulty power supply. If 115 Vac is not present, check the power source and wiring to power supply.

5-38. The 12 volt DC-AC inverter may be checked without disconnecting from the circuit or removing from the instrument. Turn the instrument off and disconnect any external load, e. g. strain gage bridge. Clip a 120 ohm 1/2 W ± 10% resistor across pins 5 and 9 of the inverter. Measure the wave shape across the resistor with the oscilloscope; the square wave should be approximately 6 volts, peak to peak, with a frequency of 1100 Hz ± 10%. Check the demodulator reference voltage across pins 6 and 8 of the inverter. It should be approximately 2 volts peak to peak. If these voltage readings are not obtained, and the power supply is satisfactory, the inverter must be replaced. Re-calibrate the indicator after the new inverter is installed.

5-39. Perform the null meter sensitivity performance check to determine the amplifier gain adjustment. If the final reading exceeds 50 microinches per inch, recalibrate the indicator and repeat the check. If the meter does not respond to recalibration, unfasten the four amplifier board screws and place the board on an insulated surface. Disconnect only the input signal leads at terminals 1 and 2. Connect the audio oscillator to these terminals and adjust the oscillator to provide an input voltage of approximately 20 micro-volts. Pinpoint the malfunction by checking the amplifier at each transistor stage, collector to collector, with the oscilloscope in the differential mode. After repairing the amplifier make the balance adjustment as described in paragraph 5-19.

5-40. Trouble shooting the measuring circuit is relatively simple. The only malfunction possible is a broken, burned or shorted resistor on the measuring board or the ADD to READING switch. Turn off instrument power and make a continuity check with the multimeter. BLH recommends replacing the ADD to READING switch with a complete unit because the application of heat required for soldering may cause a significant change in resistance and may possibly change the basic calibration. It is adviseable to return the instrument to the factory for recalibration after any repairs to the measuring circuit are made to insure preservation of original instrument accuracy.

Table 5-3. Schematic Diagram Notes

REFER TO (MIL-STD-15-1) FOR SCHEMATIC SYMBOLS NOT LISTED IN THIS TABLE

= ETCHED CIRCUIT BOARD

= FRONT PANEL MARKING

= REAR PANEL OR INTERNAL ADJUSTMENT MARKING

= FRONT PANEL CONTROL

= SCREWDRIVER ADJUSTMENT

CW = INDICATES MOVABLE CONTACT POSITION AT CLOCKWISE ROTATION LIMIT OF CONTROL SHAFT. (SHAFT VIEWED FROM KNOB OR SLOTTED END)

= PRIMARY SIGNAL PATH

= FEEDBACK PATH

= WAVEFORM TEST POINT (WITH NUMBER)

= COMMON POINT (WITH LETTER)

= AVALANCHE (ZENER) DIODE

= TUNNEL DIODE

= STEP RECOVERY DIODE

= SIGNAL GROUND

= CHASSIS

N.C. = NO CONNECTION P/O = PART OF

* = OPTIMUM VALUE SELECTED AT FACTORY, AVERAGE VALUE SHOWN; PART MAY HAVE BEEN OMITTED.

UNLESS OTHERWISE INDICATED:
CAPACITANCE IN PICOFARADS
INDUCTANCE IN MICROHENRIES
RESISTANCE IN OHMS

NUMBERS IN PARENTHESES INDICATE WIRE COLOR USING RESISTOR COLOR CODE
e.g. WHT-RED-GRN is (9-2-5)

0 – BLACK	5 – GREEN
1 – BROWN	6 – BLUE
2 – RED	7 – VIOLET
3 – ORANGE	8 – GRAY
4 – YELLOW	9 – WHITE

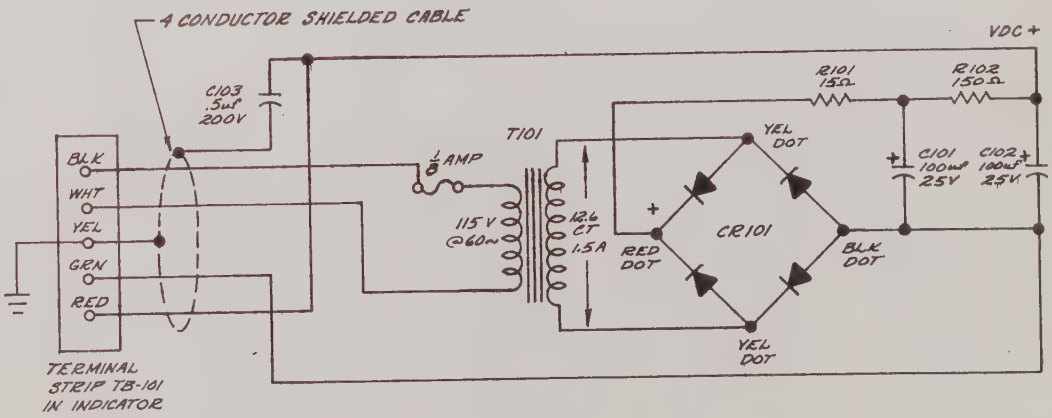


Figure 5-5. Schematic Diagram 120CA Power Supply

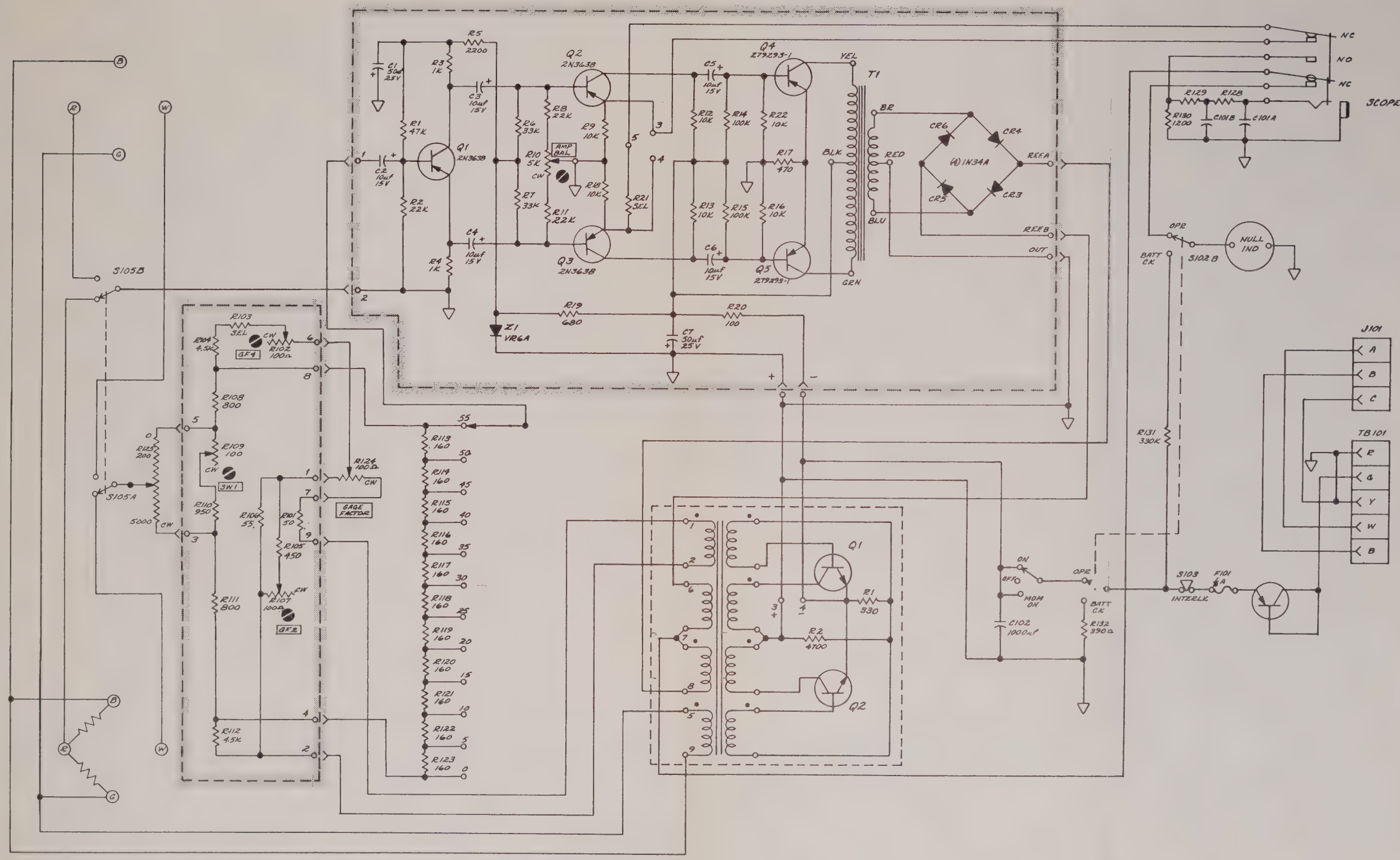


Figure 5-6. Schematic Diagram, Model 120C

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for identifying and ordering replacement parts. Table 6-1 lists in alpha-numeric order by reference designator and provides the following information on each part:

a. BLH part number (where BLH is sole source).

b. Total quantity used in the instrument TQ column). Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or 2000 hours). RS column.

d. Typical manufacturer of the part (where applicable) in a five-digit code taken from the Federal Suppply code for Manufacturers, Handbooks H4-1 (Name to Code) and H4-2 (Code to Name).

e. Manufacturer's part number.

6-3. ORDERING INFORMATION

6-4. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/Service Office (see lists at the rear of this manual) or direct to BLH. Identify parts by BLH part numbers.

6-5. To order parts not listed in Table 6-1 provide the following:

a. Model number of instrument.

b. Serial number of the unit.

c. Description of the part including function and location.

6-6. To order a part from a manufacturer other than BLH, provide the component part description and the Manufacturer's code and part number from Table 6-1.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	TC	= thermocouple
B	= motor	FL	= filter	Q	= transistor	V	= vacuum tube, neon bulb, photocell etc.
BT	= battery	HR	= heater	QCR	= transistor-diode		
C	= capacitor	J	= jack	R	= resistor	W	= cable
CR	= diode	K	= relay	RT	= thermistor	X	= socket
DL	= delay line	L	= inductor	S	= switch	XDS	= lampholder
DS	= lamp	M	= meter	T	= transformer	XF	= fuseholder
E	= misc electronic part	MP	= mechanical part	TB	= terminal board	Z	= network

ABBREVIATIONS

A	= ampere (s)	H	= henry (ies)	nA	= nanoampere (s) = 10^{-9}	Se	= selenium
Ag	= silver	Hg	= mercury	NC	= normally closed	sect	= section (s)
Al	= aluminum	Hz	= cycles per second	Ne	= neon	Si	= silicon
Au	= gold			NO	= normally open	sl	= slide
		ID	= inside diameter	NPO	= negative positive zero (zero temperature coefficient)	SPDT	= single-pole double-throw
C	= capacitor	impg	= impregnated			SPST	= single-pole single-throw
cer	= ceramic	incd	= incandescent	ns	= nanosecond (s) = 10^{-9}		
coef	= coefficient	ins	= insulation (ed)			Ta	= tantalum
com	= common			Ω	= ohm (s)	tog	= toggle
comp	= composition	KΩ	= kilohm (s) = 10^{+3}	OD	= outside diameter	tol	= tolerance
conn	= connection	kg	= kilogram			trim	= trimmer
		KHz	= kilocycle (s) = 10^{+3}	p	= peak	TSTR	= transistor
dep	= deposited			pc	= printed circuit		
DPDT	= double-pole double-throw	L	= indicator	pF	= picofarad (s) = 10^{-12}	V	= volt (s)
		lin	= linear taper	piv	= peak inverse voltage	vacw	= alternating current working volt (s)
DPST	= double-pole single-throw	log	= logarithmetic taper	p/o	= part of	var	= variable
				pos	= position (s)	vdcw	= direct current working volt (s)
		m	= milli = 10^{-3}	poly	= polystyrene		
elect	= electrolytic	mA	= milliampere (s) = 10^{-3}	pot	= potentiometer	W	= watt (s)
encap	= encapsulated	mH	= millihenry (s) = 10^{-3}	p-p	= peak-to-peak	w/	= with
		MHz	= megacycle (s) = 10^{+6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance.)	w/o	= without
F	= farad (s)	MΩ	= megohm (s) = 10^{+6}			ww	= wirewound
FET	= field effect transistor	met film	= metal film				
fxd	= fixed	mfr	= manufacturer			*	= optimum value selected at factory, average value shown (part may be omitted)
		mtg	= mounting	R	= resistor		
GaAs	= gallium arsenide	μ	= micro = 10^{-6}	rms	= root-mean-square		
GHz	= gigacycle (s) = 10^{+9}	my	= Mylar®	rot	= rotary		
gd	= guard						
Ge	= germanium						
grd	= ground (ed)						

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Table 6-1. Replaceable Parts

Ref. Design	Part No.	RS	TQ	Description	Mfr.	Mfr Pt No
End Item	279467			120 CA Strain Indicator) Figure 6-1		
	279466			120 CB Strain Indicator)		
A1			1	Assy Amplifier, Figure 6-2		
A2			1	Assy Inverter, Figure 6-3		
A3			1	Assy Measuring, Circuit, Figure 6-4		
A4			1	Assy Chassis		
A5			1	120 PS/C Power Supply		
A1	279105-4		1	Assy Amplifier, Figure 6-2		
	279107-2		1	Board: PC, Amplifier		
A1C1	135381-8			C: Fxd. Mylar 50 μf 25V		
C2	135385-8	1	5	C: Fxd. Mylar 10 μf 15V		
C3		1	5	Same as C2		
C4				Same as C2		
C5				Same as C2		
C6				Same as C2		
C7				Same as C1		
C8				Not Used		
A1CR1				Not Used		
CR2				Not Used		
CR3	135388-8	1	4	SCON device: Diode, IN34A		
CR4				Same as CR3		
CR5				Same as CR3		
CR6				Same as CR3		
CR7	135889-8			SCON Device: Zener diode, UR6-A ± 10%		
A1Q1	142094-8	1	3	TRANSISTOR: Si PNP, 2N3638		
Q2				Same as Q1		
Q3				Same as Q1		
Q4		1 pr.	2	TRANSISTOR: Si 2N3638 (Q4 & Q5 matched pair)		
Q5				Same as Q4		
A1R1	127238-8			R: COMP, 47K, 10% 1/2 W		
R2	127234-8			R: COMP, 22K, 10% 1/2 W		
R3	127218-8			R: COMP, 1K, 10% 1/2 W		
R4				Same as R3		
R5	127222-8			R: COMP, 2.2K, 10% 1/2 W		
R6	127218-8			R: COMP, 33K, 10% 1/2 W		
R7				Same as R6		
R8	127234-8			R: COMP, 22K, 10% 1/2 W		
R9	127230-8			R: COMP, 10K, 10% 1/2 W		
R10	135384-8		1	R: Variable, 5K 10% 1/2 W		
R11				Same as R8		
R12				Same as R9		
R13				Same as R9		
R14	127242-8			R: COMP, 100K, 10% 1/2 W		
R15				Same as R14		
R16				Same as R9		
R17				R: COMP, 470Ω, 10% 1/2 W		
R18				Same as R9		
R19				R: COMP, 680Ω, 10% 1/2 W		
R20				R: COMP, 100Ω, 10% 1/2 W		
R21	*			R: SEL.		
R22				Same as R9		
T1	401364-1			Transformer		

Table 6-1. Replaceable Parts (Cont'd.)

Ref. Design	Part No.	RS	TQ	Description	Mfr.	Mfr Pt No
A2	279050-2		1	Assy Inverter, Figure 6-3		
A3	279090-2			Assy Measuring Circuit, Figure 6-4		
	400007-1			Board: PC Measuring Circuit		
A3R101	134074-8			R: WW 50Ω 1/2 % 1/4 W		
R102	135645-8	1	3	R: Variable, 100Ω		
R103	*			R: WW 1/2%		
R104	134075-8		2	R: WW 4.5K, 1/2% 1/4W		
R105	134082-8			R: WW 450Ω 1/2% 1/4 W		
R106	134073-8			R: WW 55Ω 1/2% 1/4 W		
R107				Same as R102		
R108	134076-8		2	R: WW 800Ω 1/2% 1/4 W		
R109				Same as R102		
R110	134083-8			R: WW, 950Ω 1/2% 1/4 W		
R111				Same as R 108		
R112				Same as R 104		
A4				Assy Chassis		
				FRONT PANEL COMPONENTS		
A4J1	135150-8	1	2	Binding Post: Green		
J2	135145-8	1	2	Binding Post: Red		
J3	135146-8	1	2	Binding Post: White		
J4	135149-8	1	2	Binding Post: Black		
J5				Same as J 101		
J6				Same as J 102		
J7				Same as J 103		
J8				Same as J 104		
M101	400425-1	1	1	Meter Null		
MP 101	203301-1			Dial: Turn Counting (Gage Factor)		
R124	204277-1	1	1	R: Variable, 100Ω (Gage Factor)		
R126	204863-1		2	R: WW, 500Ω .05% 1/4 W		
R127				R: Same as R126		
R131	141923-8		1	R: WW, 330K, 1% 1/4 W		
R132	127213-8		1	R: COMP, 390K, 10% W		
S101	133532-8		1	Switch, Toggle		
S102	133531-8		1	Switch, Toggle		
S105	133559-8		1	Switch, Toggle		
				SIDE PANEL COMPONENTS		
A4C101	132504-8			C: 5μF (dual) 400 V		
C102	131195-8			C: 1000μF, 15V		
F101	128584-8	1	5	Fuse: 1/8 amp.		
J109	135099-8			Connector: 115 Vac Input		
J110	279102-1			Jack: Scope		
MP102	203318	1	1	Knob: Balancing		
Q101	141719-8	1	1	Transistor: Ge 2N404		
R128	127220-8		2	R: COMP, 1500Ω, 10% 1/2W		
R129				Same as R128		
R130	127219-8		1	R: COMP, 1200Ω, 10% 1/2 W		
S103	205958-1		1	Switch: PB Interlock		
TB101	124865-8		1	Terminal Strip		
XF101	131050-8		1	Fuse Holder		
A1	279125-2		1	Switch: Add to Reading		
R113	135510-8	2	10	R: WW 150Ω .05% 1/4 W		
R114				Same as R113		
R115				Same as R113		
R116				Same as R113		
R117				Same as R113		
R118				Same as R113		
R119				Same as R113		
R120				Same as R113		
R121				Same as R113		

Table 6-1. Replaceable Parts (Cont'd.)

Ref. Design	Part No.	RS	TQ	Description	Mfr.	Mfr Pt No
R122				Same as R113		
R123				Same as R113		
A4A1MP1	124852-8	1	1	Knob: Add to Reading		
S104	274377-1	1	1	Switch: Rotary		
A4A2	202786-2			Assy. Counter and Gear Head		
R125	101878-1	1	1	R: Variable 200Ω (slidewire)		
MP1	275257-3			Gearhead		
MP2	202785-1			Assy: Counter		
MP3	202782-1			Index Window		
MP4	202778-1			Assy: Gear & Bearing		
MP5	133279-8			Gear: Drive 104T		
MP6	133281-8			Gear: Idler, 20T		
MP7	128046-8			Retaining Ring		
A5	279136-2			Assy: Model 120 PS/C Power Supply		
A5C101	135108-8	1	2	C: 100 μf, 25 V		
C102		1		Same as C101		
C103	128095-8			C: 15 μf, 200 V		
CR101	135100-8	1		Rectifier		
F101	128841-8	5	1	Fuse 1/8 a		
R101	132706-8		1	R: 15Ω 5% 1/2 W		
R102	129833-8	1	1	R: 150Ω 5% 1/2 W		
T101	133361-8	1	1	Transformer		
				MISCELLANEOUS		
BT101	F4BP	1	2	Battery: 6V for Model 120CB		
BT102		1		Same as BT 101		
	202901-1		1	Battery Cable		
	102826-2	1	1	AC Power Cable W/Connectors Case		

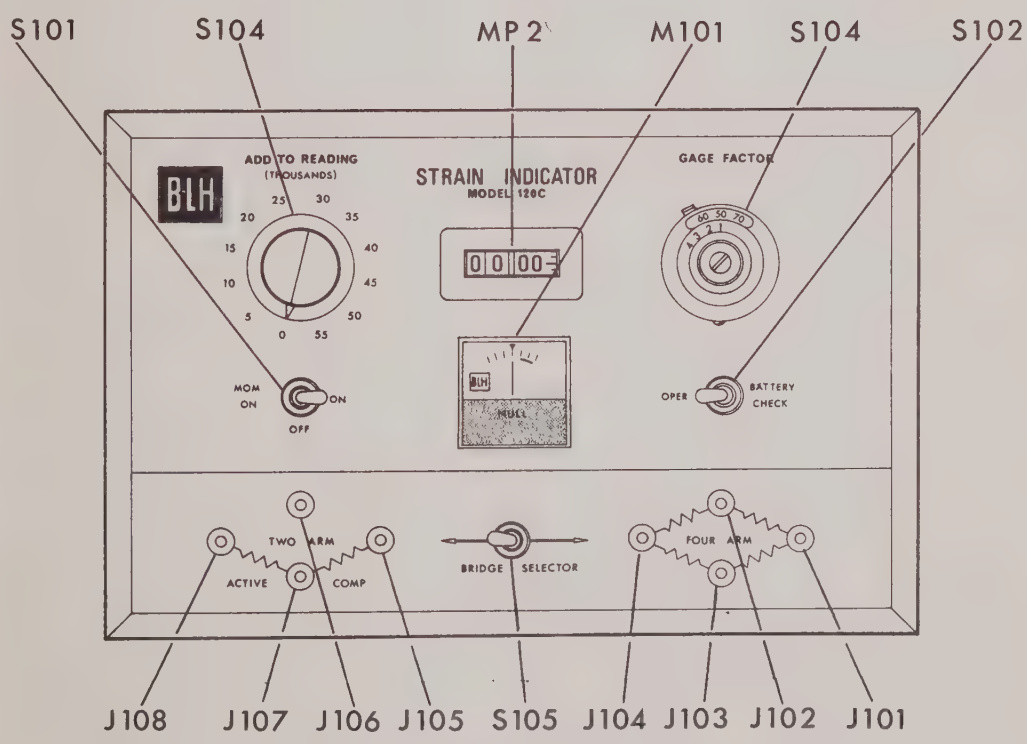

Figure 6-1. Front Panel

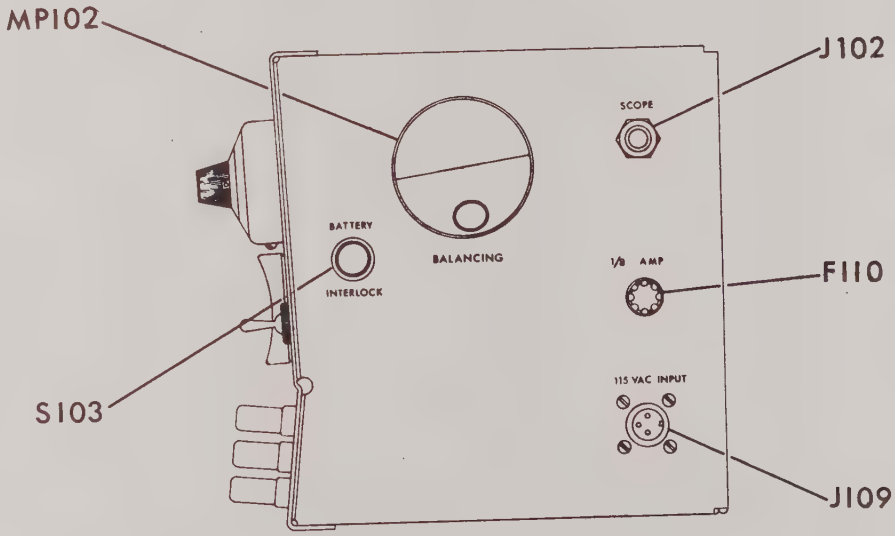

Figure 6-2. Side Panel

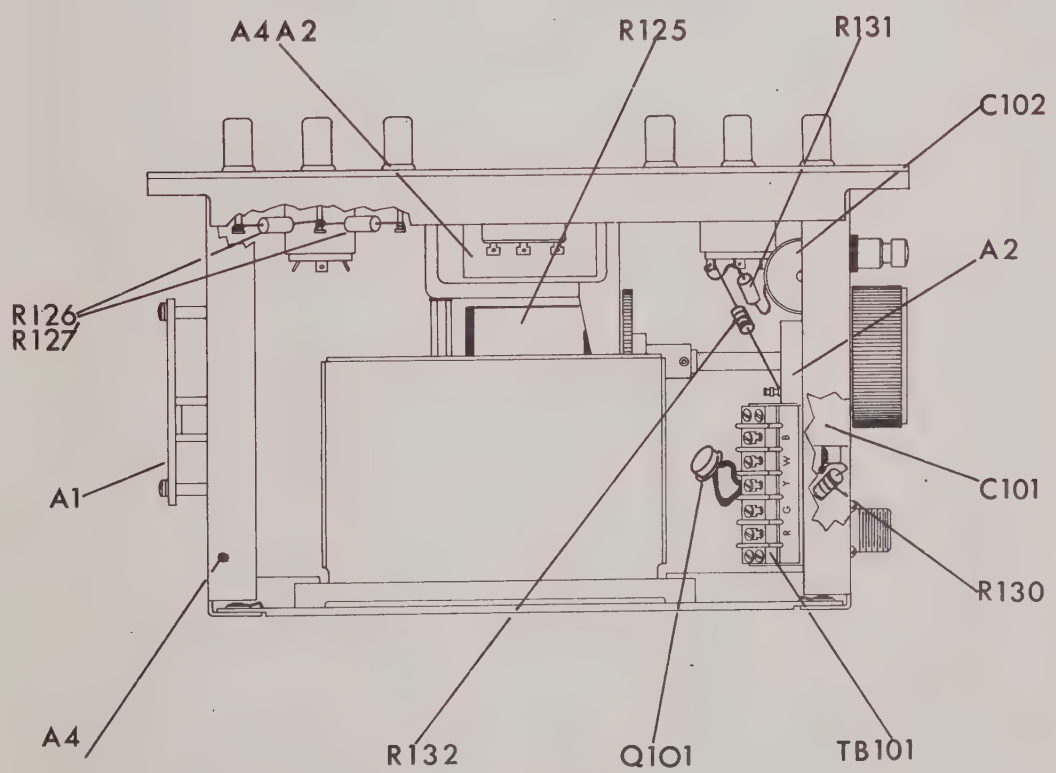

Figure 6-3. Chassis, Top View

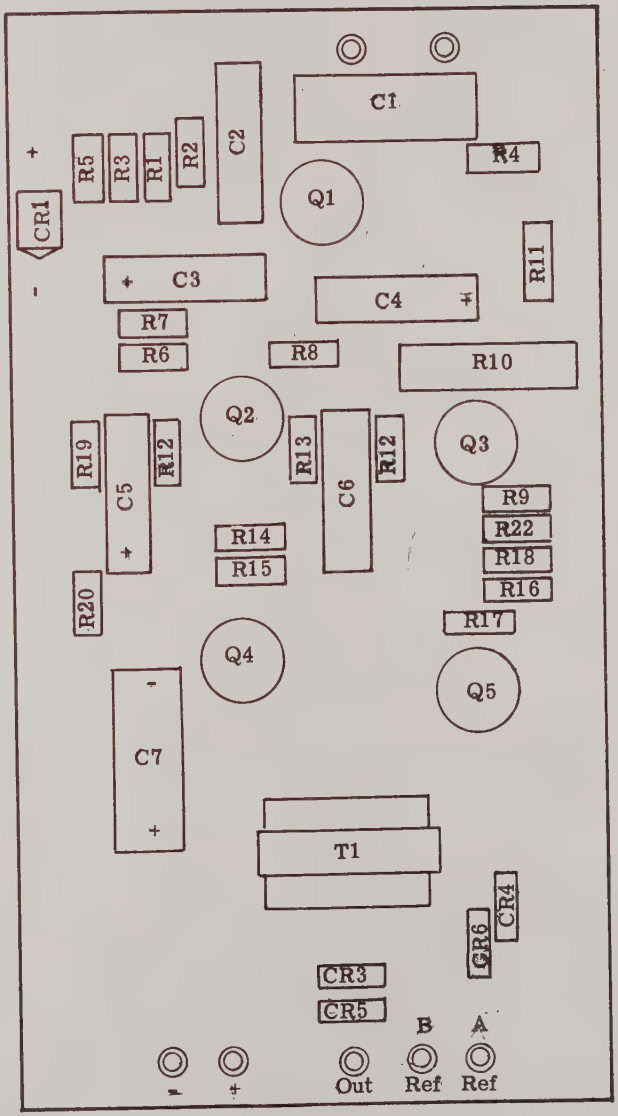

Figure 6-4. Amplifier

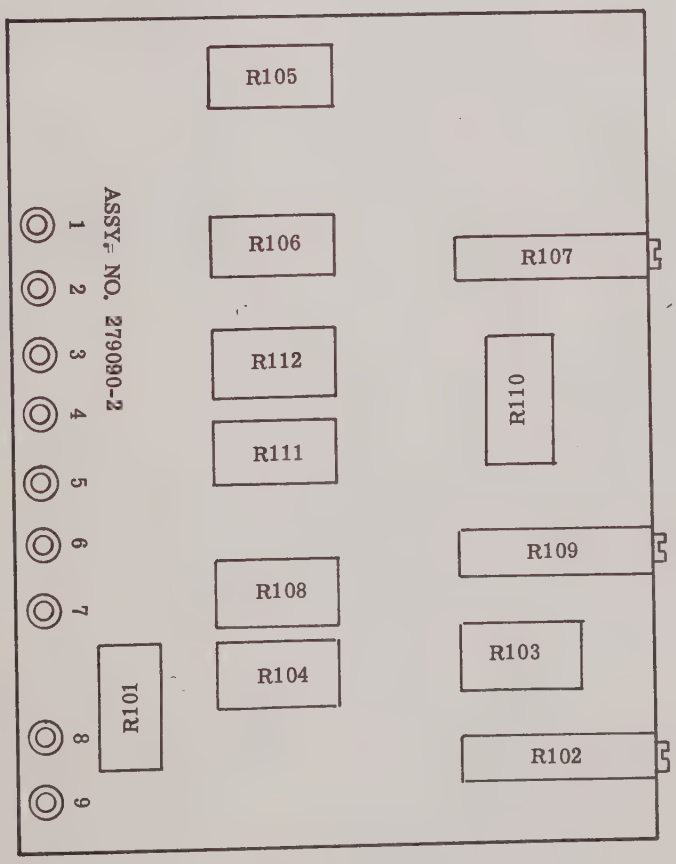

Figure 6-5. Measuring Circuit

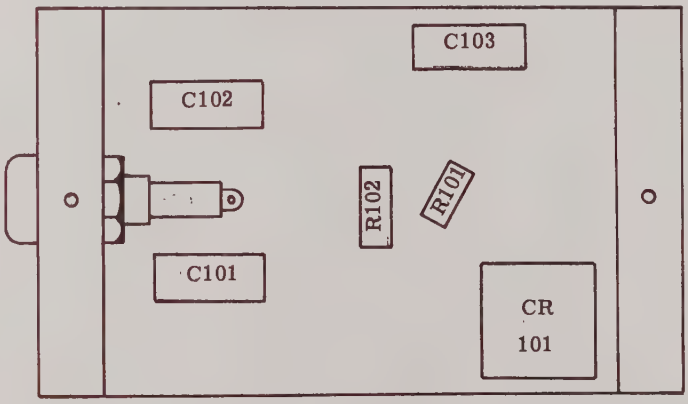

Figure 6-6. 120 PS/C Power Supply (Bottom View)

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